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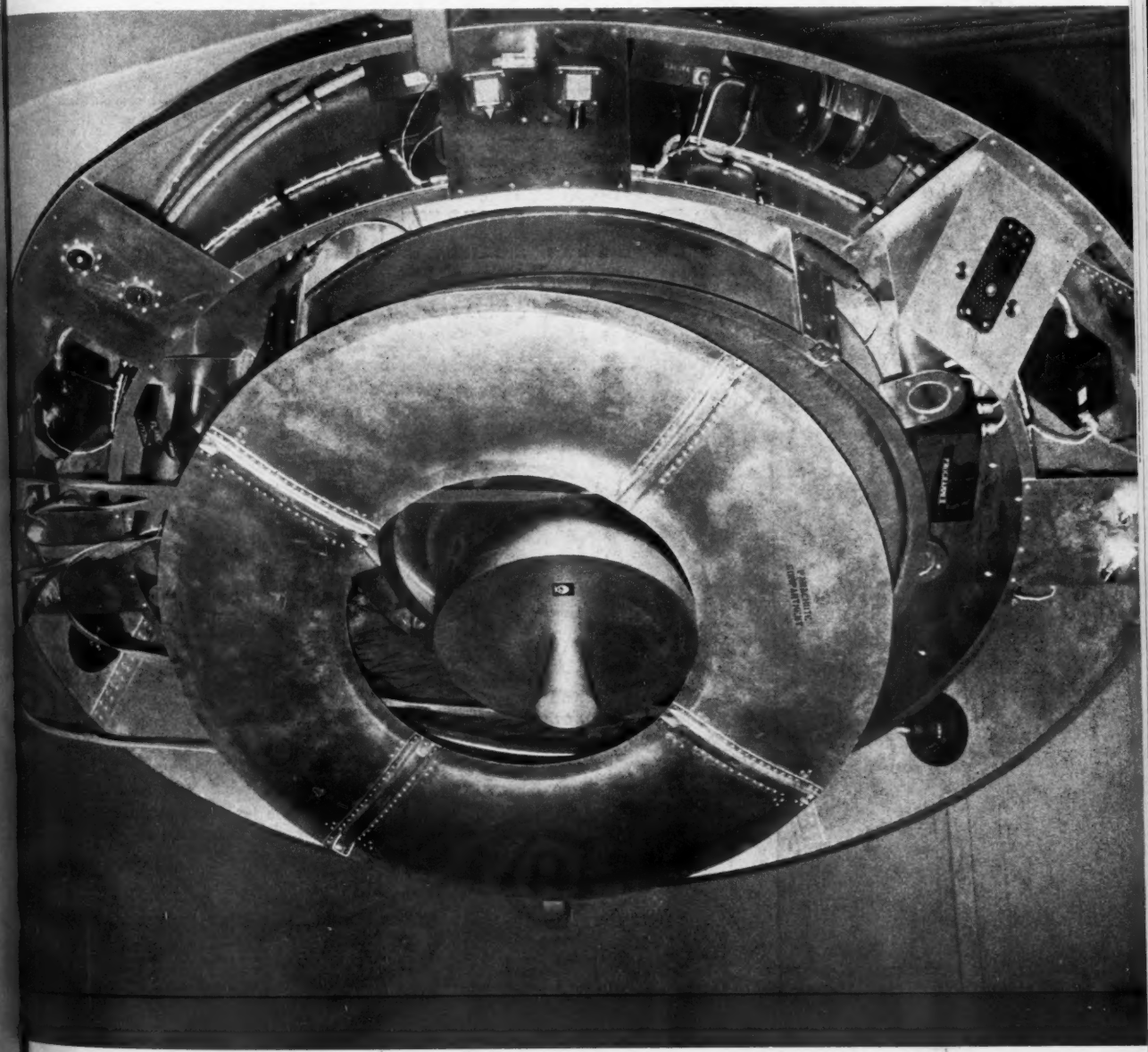
AERO/SPACE ENGINEERING

REVIEW OF CURRENT AND FUTURE TRENDS IN AIRCRAFT • MISSILES • ROCKETS • SATELLITES • SPACECRAFT



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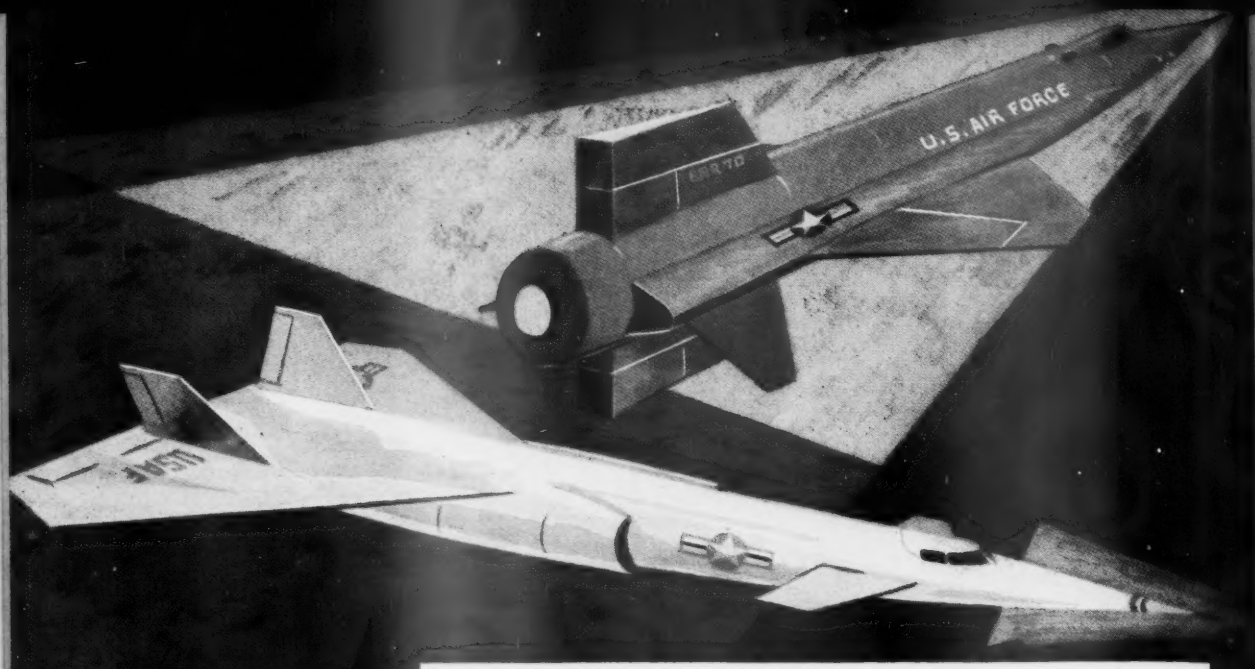
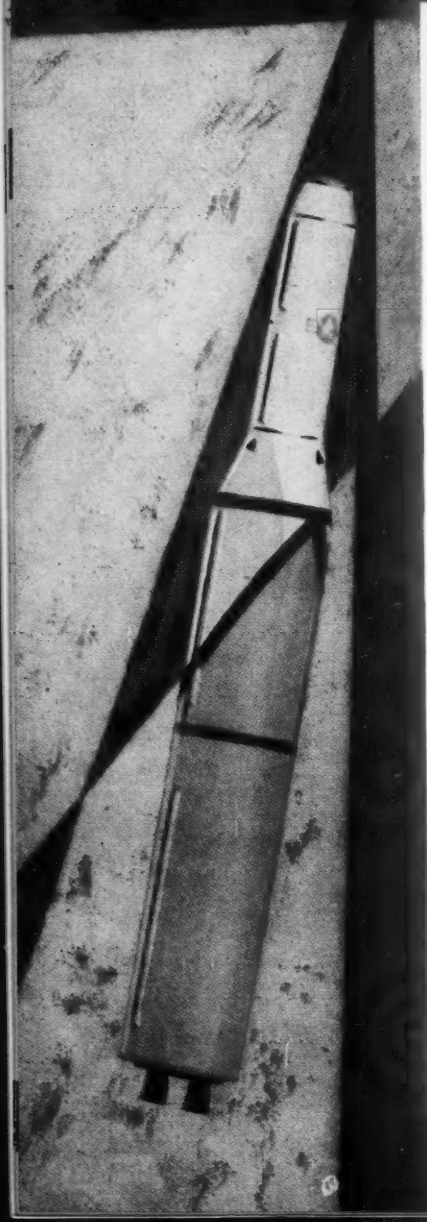
LET'S START THE DIFFICULT NOW!

Guest Editorial by Vice Adm. Selden B. Spangler, USN(Ret.)

MARCH | 1959

IAS Elections, Honors, and Awards





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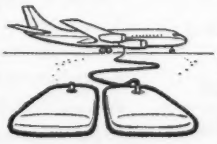

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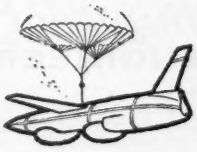

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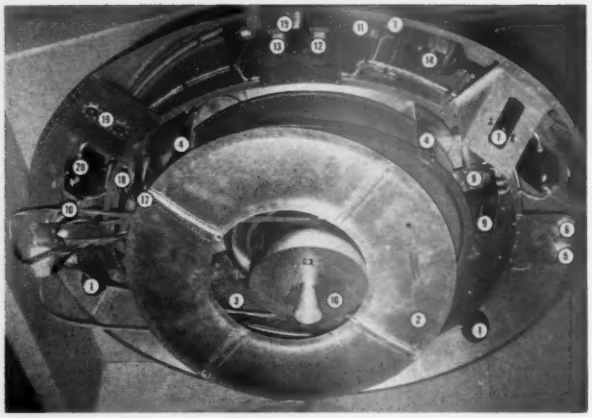

On our cover

Will the re-entry section of the first manned space cabin look like this? An exclusive Aero/Space Engineering photo illustrates design thinking in a recent study by the Missile and Space Vehicle Department of General Electric Co. Figures on the accompanying photo indicate: (1) Tracking Lights. (2) Parachute Cover. (3) Parachute. (4) Parachute Cover Ejection. (5) High-Thrust Pitch-Control Nozzles. (6) Low-Thrust Pitch-Control Nozzles. (7) Umbilical Plug. (8) Radar Chaff. (9) Programmer. (10) Decomposition Chamber. (11) Propellant Valve. (12) High-Thrust Yaw-Control Nozzles. (13) Low-Thrust Yaw-Control Nozzles. (14) Control System Propellant Tank. (15) Spin Nozzles. (16) Retrorocket. (17) Beacon. (18) Flare Antenna. (19) In-Flight Disconnect. (20) Valve.

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. . . formerly *Aeronautical Engineering Review*, is published monthly by the Institute of the Aeronautical Sciences, Inc., at 20th and Northampton Streets, Easton, Pa. Headquarters and Editorial Offices: 2 East 64th Street, New York 21, N.Y. (TEmpleton 8-3800). Western Office: 7660 Beverly Blvd., Los Angeles 36, Calif.

Subscription rates: United States and possessions, 1 year, $5.00; single copies, $0.50. Foreign countries including Canada (American currency rates), 1 year, $6.00; single copies, $0.50.

Second-class mail privileges authorized at Easton, Pa. This publication is authorized to be mailed at the special rates of postage prescribed by Section 132.122.

Notices of change of address should be sent to the Institute of the Aeronautical Sciences, Inc., 2 East 64th Street, New York 21, N.Y., at least 30 days prior to actual change of address.

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AERONAUTICAL ENGINEERING REVIEW

AERO/SPACE ENGINEERING

VOLUME 18 / NUMBER 3 March 1959

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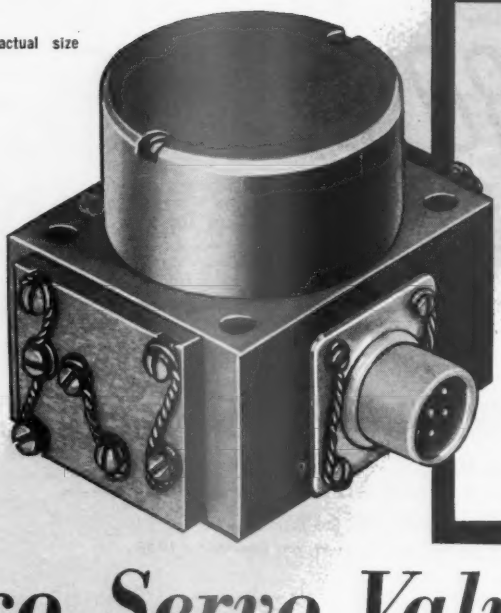

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Weight: 11 ounces
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Operating Pressure Range: 500 - 3000 psi
Temperature Range: —65° to 400°F.
Standard Coil Resistance: 1000 ohms

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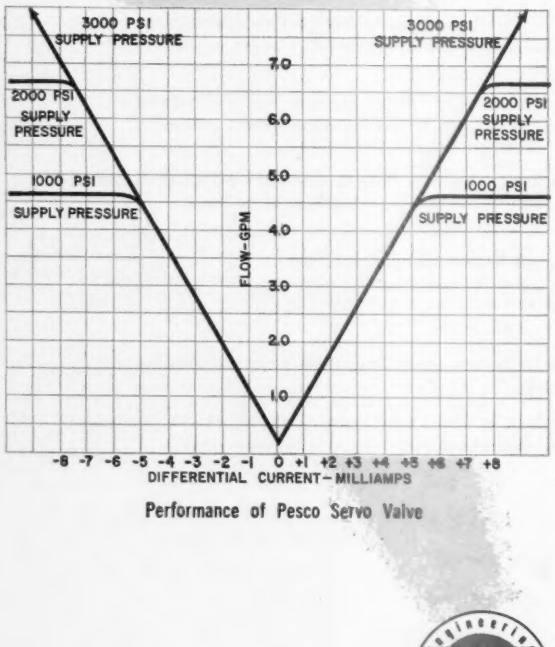

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LETTERS to the Editor

An "Abandoned" Field?

■ In reviewing the schedule for the 27th Annual Meeting of the IAS, the usual careful planning and general breadth of scope are apparent. However, it seems, at least from my point of view, that an extremely important phase of aero and space technology has been given only the briefest of consideration, if it may be said to have been given any consideration at all. This is the field of automatic control of vehicles, including their attendant power plants and their guidance and navigation systems. This should also include the general field of feedback control studies as applied to aero or space technology.

While the representation of the control field at the annual IAS meetings has been constantly decreasing, the criticality of, and general interest in, control and guidance problems have, if anything, been growing. I realize, of course, that security regulations often seriously inhibit the choice of usable subject matter; it is difficult to accept, however, that the very scanty representation of these problems in the Annual Meeting is principally a matter of security. Could it be that the IAS is abandoning the automatic control field to other professional societies?

Robert A. Summers
Chief Project Engr., Systems Engrg. Div.
Allied Research Associates

No neglect and, certainly, no abandonment of this important field is intended. The IAS Meetings Planning Committee wants more letters like this one. So come on, Engineers, get articulate!—ED.

Comments on A/SE Article

■ The suggestions of W. J. Knapp and F. R. Shanley[1] that ceramics be used structurally and not merely as coatings for metals are most stimulating, although it appears that a great deal more information on the strength and relaxation properties of both metals and ceramics at extremely high temperatures is needed for evaluation of prestressed ceramics in the range where the greatest need for new structural materials exists (say above 2,000°F.).

In their paper, however, they discuss briefly the reasons for the formation of longitudinal cracks in axial compression specimens of brittle materials. After referring to a "generally accepted" explanation by Nadai[2] that they are caused by a wedging action at the ends, they say "this explanation does not seem to apply to the ceramic wing elements because longitudinal cracking occurred in regions far removed from the end plates," and a little farther on, friction from the testing machine head is said to produce an effect "exactly opposite to that of the 'wedge' theory."

Now, the cited explanation by Nadai is not the generally accepted one, even by Nadai himself. The end-cracking referred to by him occurred in a specific test in which lead foil was used as a lubricant between the specimen and the testing machine head. The wedging action at the ends which causes splitting in ordinary tests is discussed by Nadai in the same chapter,[3] where it is pointed out that it is precisely because of the friction at the ends that conical wedges develop there and cause splitting in the *central* portion of the specimen. This sounds very much like the phenomenon observed by Shanley and Knapp.

They also refer to a theory proposed by Shanley[4] "based on the atomic arrangement at the free surfaces." Surely they mean molecular arrangement? But, as described, there is no need to consider the theory as applicable only on even the molecular level; the granular level is adequate for polycrystalline substances, and, in such heterogeneous materials as concrete, a macroscopic level would suffice. The argument is basically that a grain or similar element transmits its loads through bonds of a somewhat different material to adjacent elements in directions other than along the loading axis, with resulting local transverse tensions in some of the bonds. When these tensions exceed the strength of the bonds, splitting occurs. This theory has been stated most clearly by Terzaghi,[5] but similar or relevant ideas have been propounded by Richart, Brandtzaeg, and Brown,[6] Ros and Eichinger,[7] and Griggs.[8] All these, including Shanley,[4] refer to a kind of wedging action, whether it results from incipient shear failures on inclined planes or to the granular or submicroscopic structure of the material. The theory is consistent with the observation that the strength and ductility of brittle materials increase with a compressive octahedral normal stress.[9]

REFERENCES

[1] Knapp, W. J., and Shanley, F. R., *Ceramic Materials—Properties for Structural Applications*, Aero/Space Engineering, Vol. 17, No. 12, pp. 34–38, Dec., 1958.

[2] Nadai, A., *Theory of Flow and Fracture of Solids*, Vol. I, pp. 343–346; McGraw-Hill Book Co., Inc., New York, 1950.

[3] *Ibid.*, pp. 328, 329; Figs. 20-3 and 20-7.

[4] Shanley, F. R., Knapp, W. J., and Needham, R. A., *Prestressed Ceramic Structures*, WADC TR 54-75, Pt. II, Jan., 1955, pp. 46, 47.

[5] Terzaghi, K., *Stress Conditions for the Failure of Saturated Concrete and Rock*, Proc., ASTM, Vol. 45, 1945, pp. 777–792.

[6] Richart, F. E., Brandtzaeg, A., and Brown, R. L., *A Study of the Failure of Concrete under Combined Compressive Stresses*, Bulletin No. 185, Engrg. Experiment Sta., Univ. of Illinois, Urbana, 1928.

[7] Ros, M., and Eichinger, A., *Versuche zur Klarung der Frage der Bruchgefahr, II. Nichtmetallische Stoffe*, Diskussionsbericht 28, Eidgenossiche Materialprufungstalt, Zurich, 1928.

[8] Griggs, D. T., *Deformation of Rocks under High Confining Pressures*, J. of Geology, Vol. 44, 1936, pp. 653–669.

[9] Topping, A. D., *On Porosity and Rock Strength*, ASME Paper No. 56-PET-27, ASME Petroleum Mech. Engrg. Conf., Dallas, Sept., 1956.

A. D. Topping
Structural Design Analysis
Goodyear Aircraft Corp.

"Practical Scientist" Needed?

■ I recommend for serious reading Bill Littlewood's commentary in *A/SE*'s "Letters" feature for January.

It would be unconscionable to discredit the work of the multitude of young scientists engaged in the advancement of the aero and astronautical arts. Their efforts are inevitable in the manner of our technical objectives.

Until our entry into the so-called "space age," the process of introducing a new piece of equipment into service has been a matter of intense concentrated effort between the user (whether military or commercial) and the designer. Some of this is, perhaps, being lost in our current hysterical approach to bypass the logical areas of practicability and enter into the pure areas of theory.

As Mr. Littlewood so capably observes, "there is no substitute for practical experience." It is possible that this important element has been ignored in our anxiety to surpass the world in the space age. The cold fact remains that nothing we design is of any value if it cannot be used.

We have all been associated with the introduction of a number of new types of transport aircraft, each being more complex than its predecessor for operating personnel to comprehend. The current family of transports seems to conform to this pattern. Operating results can be related directly to the technical understanding of the people using and maintaining the equipment.

Could the Institute not contribute to this effort by recognition of the vast group of "practical men" engaged in the aero sciences? Associate Fellowships and Fellowships conferred in the areas of aircraft safety, operations, and maintenance without regard to portfolios of degrees might be in order. It is significant that few papers on these subjects have been presented before either the SAE or IAS for several years. The airlines might select some of their outstanding maintenance personnel and provide accelerated science courses similar to those offered at Harvard for outstanding administrative personnel.

It is evident that the ever-increasing gap between the creator of a design and the user must be closed by a new category of personnel, the practical scientist. Maybe it is easier to make a practical man a scientist than a scientist a practical man.

Reagan Stunkl, Burbank, Calif.

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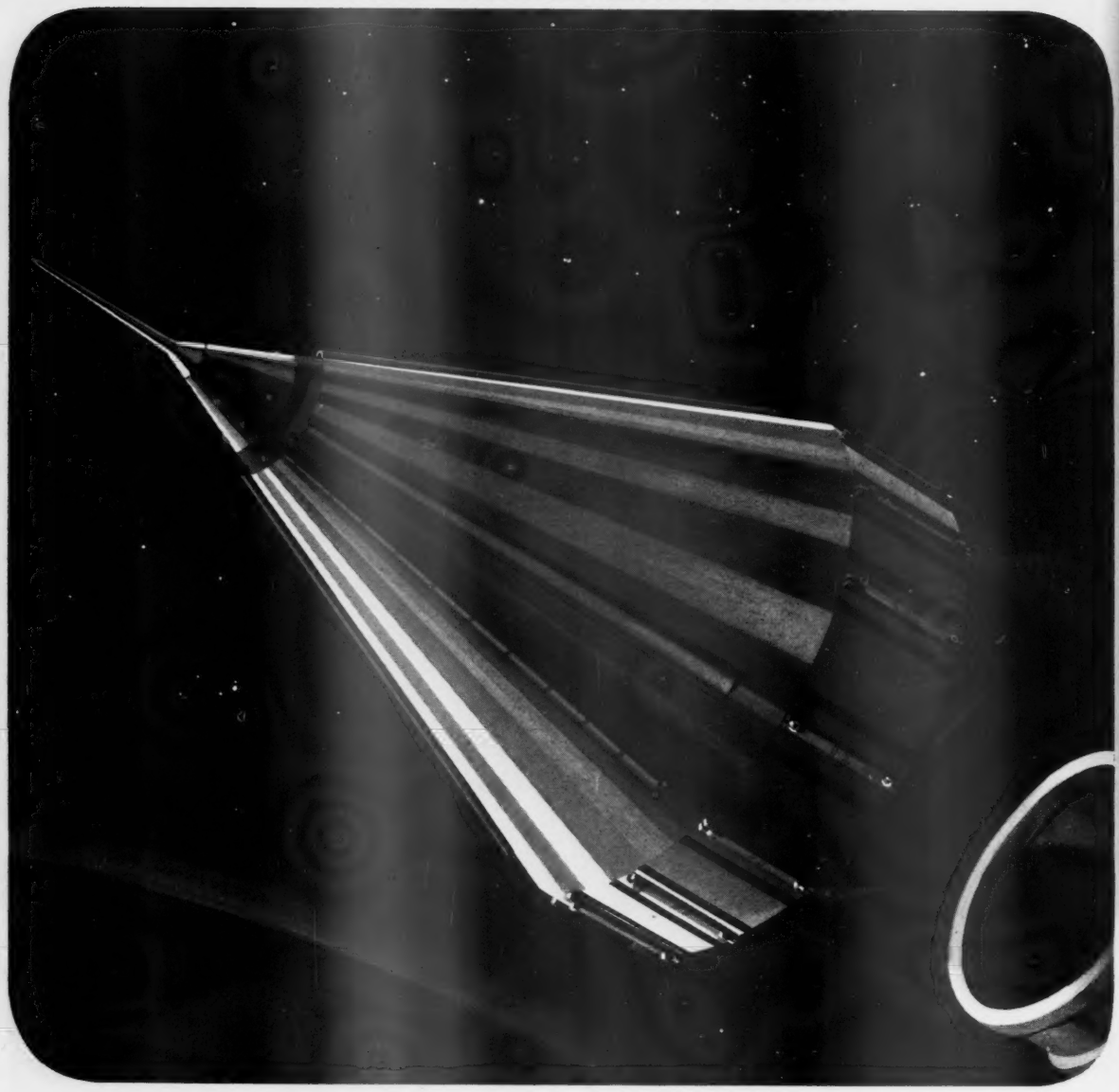

PIONEERING IN SPACE RESEARCH

Another important advance in man's knowledge of outer space was provided by Pioneer III. This, like many others of a continuing series of space probes, was designed and launched by Jet Propulsion Laboratory for the National Aeronautics and Space Administration. JPL is administered by the California Institute of Technology for NASA.

During its flight of 38 hours, Pioneer III was tracked by JPL tracking stations for 25 hours, the maximum time it was above the horizon for these stations.

The primary scientific experiment was the measurement of the radiation environment at distances far from the Earth and telemetering data of fundamental scientific value was recorded for 22 hours. Analysis of this data revealed, at 10,000 miles from the Earth, the existence of a belt of high radiation intensity greater than that observed by the Explorer satellites.

This discovery is of vital importance as it poses new problems affecting the dispatch of future vehicles into space. The study and solution of such problems compose a large part of the research and development programs now in extensive operation at the Laboratory.

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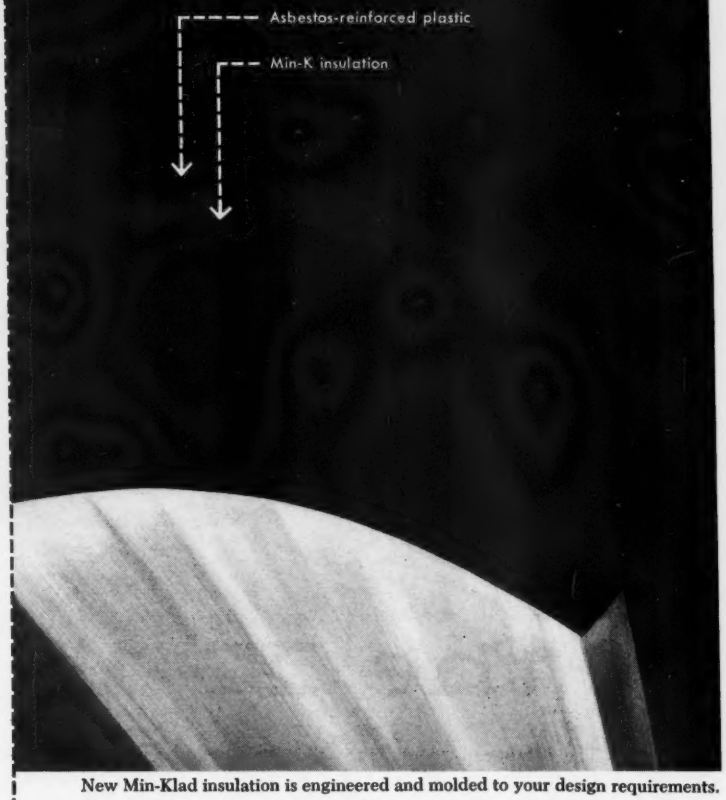

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Min-Klad is now being tested for approximately two dozen missile and rocket designs. Why not investigate this new material for your present thermal requirements? Upon request, we'll be pleased to send you a sample of the material along with detailed technical information. Write Johns-Manville, Box 14, New York 16, New York. (Ask, too, for information on Min-K insulation and the new aviation insulation brochure IN-185A.) In Canada: Port Credit, Ontario.

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the X-15

The 1-mile-per-second X-15, designed to carry its pilot into the fringes of space, is a product of joint efforts of NASA, Air Force and Navy, with close cooperation of North American Aviation, Reaction Motors and 300 other contracting firms. This aircraft —latest in a long-term program conceived by NASA scientists for the advanced study of the problems of flight—will make its first flights soon. NASA has technical direction of the X-15 project and will report the research results for use by Government and industry.

The X-15 is a *rocket research airplane*, a flying laboratory.

Primary research interest in the X-15 is to obtain knowledge of actual flight conditions in the near space environment, to produce a wealth of information from repeated missions involving entry into and exit from the atmosphere. And *only man* can prove how man will react in space to weightlessness and intense acceleration and deceleration.

The X-15 program is typical of the exciting things happening at NASA, whose responsibility it is to direct and implement U. S. research efforts in aeronautics and the exploration of space, for peaceful purposes and the benefit of all mankind.

NASA offers unique opportunities in basic and applied research in aeronautics and space technology—

For Engineers:
Aeronautical, Engineering Physics, Electronic, Mechanical, Electrical, Metallurgical, Chemical, Civil.

For Scientists:
Astronomers, Physicists, Mathematicians, Chemists, Metallurgists.

Please address your inquiry to the Personnel Director of any of the following NASA research centers:

- **Langley Research Center, Hampton, Virginia**
- **Ames Research Center, Mountain View, California**
- **Lewis Research Center, Cleveland, Ohio**
- **High-Speed Flight Station, Edwards, California**
- **Beltsville Space Center 4555 Overlook Ave., Washington, D.C.**

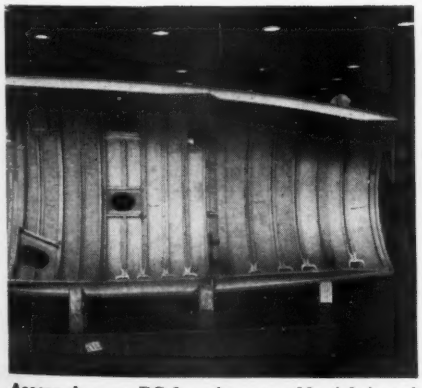
(Positions are filled in accordance with Aeronautical Research Announcement 618)

NASA National Aeronautics and Space Administration

For improved strength / weight in the...

DC-8

1667 TtitaniUM PARTS!



Access door *on DC-8 engine assembly, fabricated entirely of titanium. Skin is .016" thick, ribs and longerons are .032" thick.*

Access doors on engine assemblies, pylon skirts, and hundreds of other structural parts on the Douglas DC-8 are fabricated from high strength, light weight, corrosion resistant titanium.

Mallory-Sharon service engineers have worked closely with Ryan Aeronautical Company engineers—a major supplier of parts and components for the DC-8. New high strength titanium alloys, improved methods of machining and forming, have been developed and employed. The result has been increasingly wide application of titanium's weight-saving advantages—*up to 57%* over stainless steel in many cases.

May we help *you* gain more benefit from titanium's unusual capabilities? Our experienced Service Engineering group is ready to assist you. Or write for new bulletin on Recommendations for Machining Titanium.

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Research: opens the door to space

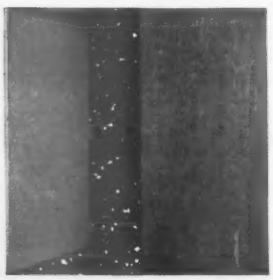
Space Technology Laboratories is responsible for the over-all systems engineering, technical direction, and related research for the U.S. Air Force Ballistic Missile Programs. To carry out the fundamental investigations of those physical phenomena related to very advanced and long-range problems of space technology, STL established the Physical Research Laboratory.

This laboratory is making significant contributions in experimental and theoretical research in the fields of controlled fusion and associated plasma physics, magnetoaerodynamics and low temperature solid state physics.

Dr. Milton U. Clauser, Vice President of the Company and Director of STL's Physical Research Laboratory, draws upon a rich background of industrial, as well as academic, experience and achievement in charting the areas of research that will be important to the space technology of the future.

The professional staff of the Physical Research Laboratory, the majority of whom hold the Doctorate, are supported by unusual shop facilities and a complete staff of technicians. Also available is an outstanding digital computing center within the STL complex. Scientists and engineers with competence and imagination in fields related to advanced cryogenics, fusion physics and magnetohydrodynamic investigation, are invited to inquire about Staff positions.

Space Technology Laboratories, Inc.



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to look to the world's most experienced supplier,
to get brakes that were up to the exacting standards
of these swept-wing giants.

. . . For similar reasons
Bendix Brakes are regular equipment
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. . . Brakes-by-Bendix is another reason why
you can fly the jetliners with complete assurance.

BENDIX PRODUCTS DIVISION **SOUTH BEND, IND.**

Bendix
AVIATION CORPORATION

Produced by Rohr to test manufacturing feasibility, this 6 by 12 foot panel represents a giant stride toward meeting the structural demands of modern flight.

A variety of structural inserts and external fittings, such as might be required in actual production units, have been incorporated.

Manufactured to highest possible brazing standards, the construction of such a panel is perhaps the surest path through the thermal barrier confronting today's designer of aircraft and missiles.

Busy building the biggest and best in honeycomb structure.

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AIRCRAFT CORPORATION

MAIN PLANT AND HEADQUARTERS: CHULA VISTA, CALIF.; PLANT: RIVERSIDE, CALIF.: ASSEMBLY PLANTS: WINDER, GA.; AUBURN, WASH.

Type 1602-B

ADMITTANCE METER

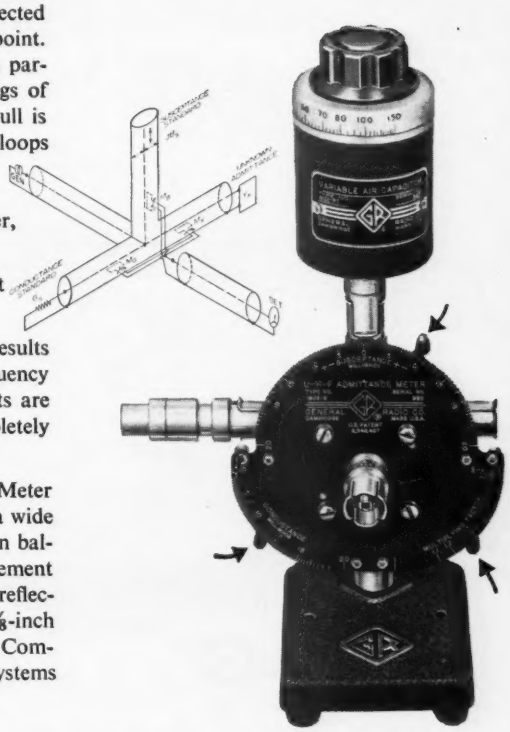
for Impedance, Admittance, and VSWR Measurements from 20 to 1500 MC

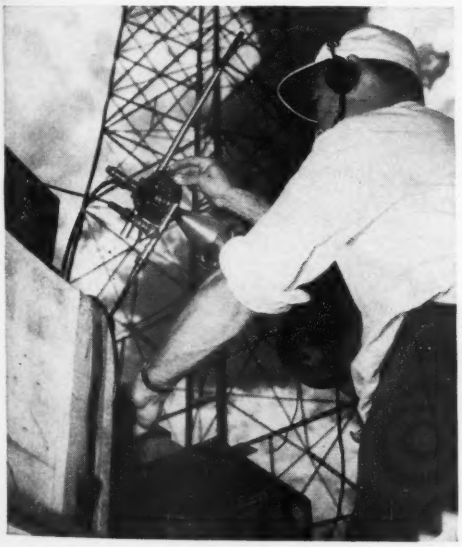
SIMPLE IN DESIGN... Three branch coaxial lines, one containing a conductance standard, one a susceptance standard, and one connected to the unknown, are fed from a voltage source at a common junction point. Three independently adjustable loops with their outputs connected in parallel are used to sample the magnetic fields in the lines. The couplings of the loops to their respective lines are adjusted by rotation until a null is obtained. At null, the settings of the conductance and susceptance loops times a multiplying factor established by the third loop give directly the conductance and susceptance of the unknown. By adding a ¼-wavelength line between the unknown and the Admittance Meter, the indicating scales become *direct reading in resistance and reactance.*

ACCURATE . . . The high accuracy of this instrument is the direct result of its simplicity. Accuracy of calibration is held indefinitely.

EASY TO USE . . . Only three levers to adjust . . . measurement results are read directly from dial calibrations that are independent of frequency . . . no sliding balance to chase all over the dial, because adjustments are independent of each other . . . line-length corrections can be completely eliminated with an accessory Constant-Impedance Adjustable Line.

VERSATILE . . . Because operation is so basic, the Admittance Meter can, with the addition of a few simple accessories, be readily used in a wide variety of measurements. Available are: a Balun for measurements on balanced lines and circuits, a Component Mount for convenient measurement of circuit elements at high frequencies, terminations for measuring reflection coefficient, and a complete line of adaptors from BNC to 3⅛-inch rigid line for measurements involving almost any connector system. Compact but high-powered Unit Oscillators and Heterodyne Detector Systems are available for use over the Admittance Meter's entire range.





Measuring standing-wave ratio on UHF-television transmitting antenna with the Admittance Meter. Connection at the "unknown" terminal is the only point of support and is made possible by the light weight and compactness of this instrument (base has been removed).

SPECIFICATIONS

FREQUENCY RANGE: — 20-1500 Mc; direct reading between 41 and 1500 Mc — useful for matching to 2000 Mc.

IMPEDANCE RANGE: — with Type 874-LK Constant-Impedance Adjustable Line, 1 to 5000 ohms resistive, and ±1 to ±5000 ohms reactive.

ADMITTANCE RANGE: — Conductance, 0.2 to 1000 millimhos; susceptance, ±0.2 to ±1000 millimhos.

VSWR RANGE — 1 to 10.

ACCURACY — for both conductance and susceptance at frequencies to 1000 Mc (only slightly less accurate to 1500 Mc):

. . . ±(3% + 0.2 millimho) to 20 millimhos

. . . $\pm(3\sqrt{M}\% + 0.2$ millimho) from 20 to ∞ millimhos; "M" is scale multiplying factor

. . . for matching, 3% accuracy to 2000 Mc.

ACCESSORIES SUPPLIED — 50-Ω Termination, Adjustable Stub, Shielded Variable Air Capacitor, Patch Cords, and Type 874 Panel Connector

PRICE — $295

ADDITIONAL ACCESSORIES AVAILABLE — For a complete listing of generators, null detectors, and coaxial elements, write for the General Radio VHF-UHF Instrument Bulletin.

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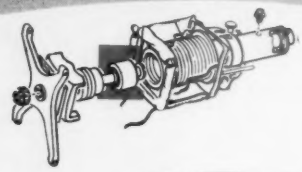
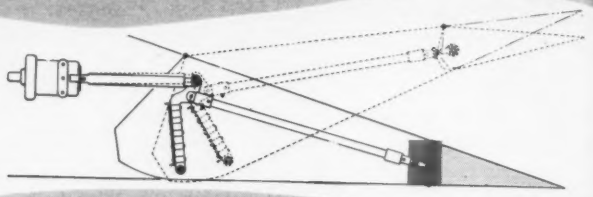
SHAFER® BEARINGS CARRY THE LOAD



Elevator flight controls

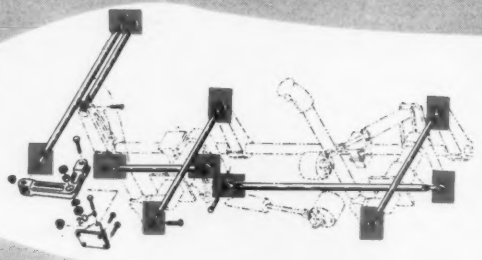


Aileron trim and servo tab control system

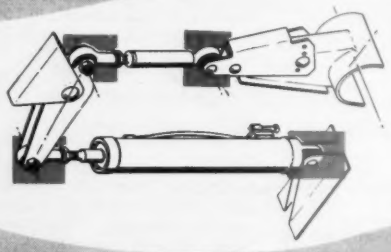
Main landing gear fulcrum and linkage

Wing flap hinge and linkage

Aileron hinge



Helicopter flight control group



Hydraulic actuator linkage

Helicopter blade pitch control link

Wherever design criteria call for greatest load-carrying capacity...smallest envelope dimensions and weight...Shafer Self-Aligning Anti-friction Bearings are specified today! Shafer Bearing Division, CHAIN Belt Company, Downers Grove, Ill.

SHAFER® AIRCRAFT BEARINGS

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IAS News Notes

March 1959

Coming Next Month: Special A/SE Issue on Space Flight

Several months in the making, one of the most ambitious undertakings in recent years by Aero/Space Engineering is nearing final form. This will be A/SE's first special-interest volume of 1959 - the April Space Flight Issue, with Louis G. Dunn, President of Space Technology Laboratories, Inc., as Guest Editor. Dr. Dunn comments on the national space program, while 12 additional distinguished engineer-scientists discuss aspects of space flight in especially prepared articles available to the scientific community only in this unusual issue. These contributors are Robert H. Boden, Clayton C. Clark, Jr., Harry Esses, H. Franklin Gregory, Hugo Mohrlock and Earl A. Kops, C. J. Mundo, Jack N. Nielsen, Richard H. Parvin, Louis N. Ridenour and Bruno W. Augustein, Edgar Schmued, H. Guyford Stever, and James D. Welterlen. Our cover, in color, has been prepared especially for the issue by Fred Wolff, Astronautical Illustrator.

BETTER IDENTIFICATION OF AUTHORS whose technical writings appear in Aero/Space Engineering is the aim of two innovations to be noticed in next month's special Space Flight Issue, and in all succeeding issues. This will be achieved by use of photos of authors, plus Tom Thumb biographies, and listing of each author's grade of IAS membership.

THE FULL SCHEDULE OF IAS REGIONAL STUDENT CONFERENCES has been completed. Places and dates are: Northeastern--April 4, Cornell University; Southeastern--April 9-10, Atlanta, Ga.; Southwestern--April 16-18, Ft. Worth, Texas; St. Louis--April 23-24, St. Louis, Mo.; Middle-Atlantic--May 1-2, Catholic University, Washington, D. C.; Detroit--May 5, University of Detroit; West Coast--April 30-May 1, IAS Building, Los Angeles.

INTERNATIONAL, NATIONAL & JOINT MEETINGS CALENDAR

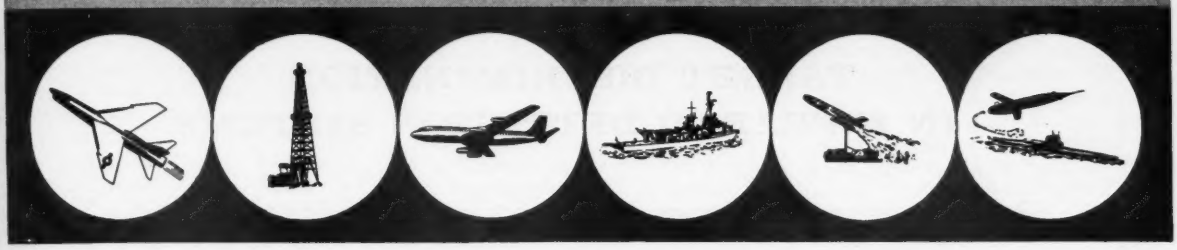
Mar. 5-6	IAS Flight Propulsion Meeting (Classified), Cleveland.
Apr. 5-10	1959 Nuclear Congress, Municipal Auditorium, Cleveland.
May 25-27	National Telemetering Conference, Cosmopolitan Hotel, Denver. Sponsored by IAS, ARS, ISA, and AIEE.
June 11-13	1959 Heat Transfer and Fluid Mechanics Institute, University of California, Los Angeles. Cosponsored by IAS.
June 16-19	IAS National Summer Meeting, Los Angeles.
Sept. 9-11	Midwestern Conference on Fluid and Solid Mechanics, University of Texas, Austin. Cosponsored by IAS, AFOSR, ONR, NSF, and 11 technical societies.
Oct. 5-16	Seventh Anglo-American Aeronautical Conference, New York.
Nov. 2-4	IAS National Midwestern Meeting on "New Frontiers in Aviation", Lassen Hotel, Wichita, Kansas.

SECTION MEETINGS CALENDAR

Mar. 2	Atlanta: Joint Dinner Meeting with SAE, Hellenic Center. "Development of the Polaris IRBM" by Stanley W. Burriss.
Mar. 3	Los Angeles: Specialist Meeting, IAS Building, 8 p.m. "A Review of Recent Developments in Rarified Gas Dynamics Research" by S. A. Schaaf.
Mar. 4	Philadelphia: Joint Dinner Meeting with AHS (Social period 6:30, dinner 7, talk 8 p.m.), Penn-Sherwood Hotel. "Review of Army Aerial Jeep Program" by Col. George P. Seneff.
Mar. 5	Baltimore: Dinner Meeting (Cocktails, dinner 6, meeting 8 p.m.), Officers Club, Aberdeen Proving Grounds. "Army Research and Development Requirements" by Major Gen. Robert J. Wood, USA.
Mar. 5	Los Angeles: Dinner and Tour of WAL Maintenance Facilities, Western Airline Building, L. A. International Airport, 6:30.
Mar. 10	Los Angeles: Specialist Meeting (Classified), IAS Building, 8 p.m. "F107/F104 Induction Systems" by H. Drell, M. Sulkin, A. Brown.
Mar. 10	Wichita: Specialists Meeting, Innes Tearoom. "Aerodynamics - Propulsion - Structures".
Mar. 11	Chicago: Dinner Meeting (Dinner 6:30, meeting 7:30 p.m.), Illinois Institute of Technology. "What is the Future of the Light Plane?" by W. D. Thompson.
Mar. 11	Niagara Frontier: Technical Meeting, Cornell Aeronautical Lab. (Buffalo), 8:30 p.m. "The Configuration Development of the B-58 Supersonic Bomber" by George C. Grogan, Jr.
Mar. 12	Detroit: Joint Dinner Meeting & Forum with ARS and Michigan State Bar Assn. (Dinner 6:00, forum 8 p.m.), Rackham Auditorium, Engineering Society of Detroit. "Techno-Legal Aspects of Space Exploration."
Mar. 17	Dayton-Cincinnati: Dinner Meeting, Embers Supper Club. "VTOL Aircraft Development at Vertol" by W. Z. Stepniewski.
Mar. 17	Texas: Specialists Meeting, Arlington State College, 8 p.m. "Development of the XKDT-1 Target Drone" by J. G. Evans.
Mar. 18	Columbus: Joint Meeting with Student Branch, Ohio State University. Panel discussion on "Considerations of Preliminary Design" by members Columbus Div., North American Aviation Inc.
Mar. 18	San Antonio: Tour of Howard Aero Mfg. facilities, 7 p.m., San Antonio International Airport. "The Pressurized Super Ventura" by officials of Howard Aero Mfg.
Mar. 19	Los Angeles: Dinner Meeting (Social hour 6, dinner 7, meeting 8 p.m.), IAS Building. Panel discussion on "Operation of Commercial Jet Aircraft" by staff members of AAL, BOAC, PAA.
Mar. 24	Los Angeles: Specialist Meeting, IAS Building, 8 p.m. "Boundary Layer Response to Impulsive Motion" by M. Rosenzwerg and J. K. Wall.
Mar. 24	Washington: Dinner Meeting, University Dining Hall, University of Maryland, (College Park, Md.), 6:30 p.m. Lecture 8 p.m., Student Union Building, on "Rocket Propulsion Systems for Space Flight" by Prof. G. P. Sutton and Prof. J. Hunsaker, MIT.

SARGENT

SERVO-SYSTEMS OF FORCE CONTROL



With 38 years acceptance Sargent builds precision linear and rotary hydraulic, pneumatic, mechanical and electronic systems of force control to meet successfully the increasingly high requirements of marine, aircraft, missile, petroleum and industrial use. From original idea to finished product – SARGENT.

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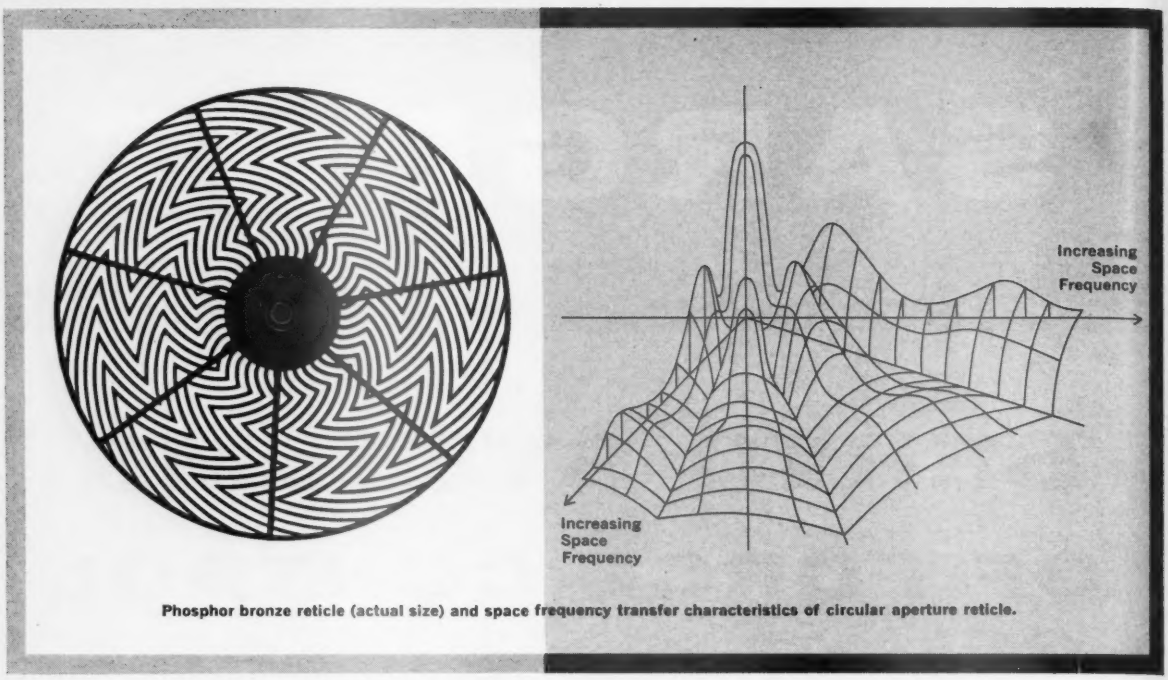
"GOOD WILL" is the disposition of the pleased customer to return to the place where he has been well treated.
– U.S. Supreme Court



Phosphor bronze reticle (actual size) and space frequency transfer characteristics of circular aperture reticle.

TARGET DISCRIMINATION IN INFRARED DETECTION SYSTEMS

The pioneering field of infrared detection offers many challenging opportunities to scientists and engineers at Ramo-Wooldridge for advanced studies in the solution of target discrimination problems. Research is continually under way at Ramo-Wooldridge in the integrating of infrared detection devices with the latest electronic systems techniques for enhanced target detection on the ground and in the air.

The phosphor bronze reticle, or image chopper, illustrated above was developed by Ramo-Wooldridge. It indicates a marked stride in space filtering discrimination concepts, and is used for target signal enhancement in guided missiles, anti-aircraft fire control and air collision warning applications.

The reticle is used in the focal plane of an infrared optical system and is rotated to chop the target image for the desired space filtering. It is also employed in time filtering, such as pulse length discrimination, or pulse bandwidth filtering.

Space filtering is critical to infrared systems, because of its ability to improve the detection of objects located in the midst of background interference. In a manner similar to that used in the modification of electronic waveforms by electrical filtering, space filtering enhances the two-dimensional space characteristics of a target. The size and features of the target are highlighted and the undesired background eliminated.

Scientists and engineers with backgrounds in infrared systems—or any of the other important areas of research and development listed below—are invited to inquire about current opportunities at Ramo-Wooldridge.

- Electronic reconnaissance and countermeasures systems
- Analog and digital computers
- Air navigation and traffic control
- Antisubmarine warfare
- Basic research
- Electronic language translation
- Information processing systems
- Advanced radio and wireline communications
- Missile electronics systems

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IAS News

. . . a record of people and events of interest to Institute Members

Annual Business Meeting of the Institute

Reports of President, Treasurer, and Director

THE TWENTY-SEVENTH ANNUAL MEETING of the members of the Institute was held at the Hotel Astor, New York, on January 28, 1959. Edward C. Wells, President, presided.

Elmer A. Sperry, Jr., Teller, reported that he had received and counted 1,684 valid proxies for voting at the Annual Meeting—a quorum of the voting membership.

Preston R. Bassett, Chairman of the Nominating Committee, placed in nomination the following members for election to vacancies on the Council:

William Littlewood, Edward C. Wells, Clifford C. Furnas, Clarence L. Johnson, I. Nevin Palley, Raymond C. Sebold, and Jerome Lederer, for a term of 1 year each; Milton U. Clauser, George F. Douglas, L. Eugene Root, William R. Sears, and H. Guyford Stever, for a term of 3 years each; R. Dixon Speas for a term of 2 years; and the following area councilors for a term of 1 year each: Eastern Area—Theodore H. Beck and Clifford E. Roberts; Central Area—Paul H. Dane and Milford F. Vanik; Western Area—Dean R. Chapman and M. Carl Haddon. On motion duly made, seconded, and carried, they were unanimously elected. The following were nominated and elected in like manner to serve on the Nominating Committee for 1959: Mundy I. Peale, Chairman, C. J. McCarthy, Jack Parker, A. E. Raymond, L. Eugene Root, Ira G. Ross, H. Guyford Stever, and Edward C. Wells.

The Annual Reports of the President, Treasurer, and Director were read and approved. (See the following pages for the complete reports.)

The Secretary presented a list of honors conferred by the Institute in 1958 as follows: The Octave Chanute Award to A. Scott Crossfield, Development Engineer and Experimental Test Pilot, North American Aviation, Inc.; the Louis W. Hill Space Transportation Award presented posthumously to Robert H. Goddard; the John J. Jeffries Award to Hubertus Strughold, M.D., Professor of Space Medicine and Advisor for Research, School of Aviation Medicine, USAF; the Robert M. Losey Award to Patrick D. McTaggart-Cowan, Associate Director, Canadian Meteorological Service; the Sylvanus A. Reed Award to Victor E. Carbonara, President, Kollsman Instrument Corporation; the Lawrence A. Sperry Award to Robert G. Loewy, Chief Technical Engineer, Vertol Aircraft Corporation; the Water-Based Aviation Award to F. W. S. Locke, Jr., Research Division, Bureau of Aeronautics; the Minta Martin Aeronautical Student Fund-National Paper Awards to: Graduate Division—Joseph Tsu Chieh Liu, University of Michigan; Undergraduate Division—Robert H. Tolson, Virginia Polytechnic Institute; and the Wright Brothers Lecturer, Maurice Roy, Director, Office National d'Études et de Recherches Aéronautiques (ONERA), who spoke on "Means and Examples of Aeronautical Research in France."

Honorary Fellowships in the Institute to: American—Charles S. Draper, Head, Department of Aeronautics and Astronautics, Massachusetts Institute of Technology; Foreign—Sir George Edwards, Managing Director, Vickers Armstrongs (Aircraft) Limited.

Fellowships in the Institute to: A. M. Ballantyne, Secretary, The Royal Aeronautical Society; Ralph L. Bayless, Chief Engineer, San Diego Division, Convair; Dean R. Chapman, Aeronautical Research Scientist, Ames Research Center, NASA; R. R. Gilruth, Assistant Director, Langley Research Center, NASA; Henry Görtler, Director of Mathematical Institute, University of Freiburg/Br.; Richard Greinacher, Section Chief (Aviation), Service Technique Militaire; Simon Ramo, Executive Vice-President, Thompson Ramo Wooldridge, Inc.; Homer J. Stewart, Director, Office of Program Planning and Evaluation, NASA; Charles Tilgner, Jr., Chief Aeronautical Engineer, Grumman Aircraft Engineering Corporation; and Karl D. Wood, Professor of Aeronautical Engineering, University of Colorado.

The Secretary announced that the Council had elected the following officers of the Institute for 1959: President, William Littlewood; Vice-Presidents, Clifford C. Furnas, Clarence L. Johnson, I. Nevin Palley, and Raymond C. Sebold; Treasurer, Jerome Lederer; Director, S. Paul Johnston; Secretary, Robert R. Dexter; and Controller, Joseph J. Maitan.

ROBERT R. DEXTER
Secretary

President's Report—1958

IN MAKING my report for 1958, I will not outline in detail the events of the year since these are adequately presented in reports of the IAS staff. I will refer rather to a few significant items which are illustrative of 1958 IAS activity and which point the way toward future progress.

1958 was a year of international competition, paralleled paradoxically by the development of international cooperation. The IAS, thanks to the support of Harry F. Guggenheim, was privileged to join with other national scientific societies in holding the first International Congress of the Aeronautical Sciences in Madrid in September. This Congress, and those to follow, provide an effective means for continuing and increasing international understanding, so clearly needed in this era of rapidly changing technology and world relationships.

1958 was a year of increased attention to, and critical review of, our educational processes and standards. Within the IAS, this was reflected in increased activity in Student Branches and in participation in our affairs by outstanding educators and scientists.

1958 was a year of accelerated scientific and engineering activity, reflected by an ever-increasing scope of IAS meetings coverage and by the establishment by the Hill Family Foundation of the Hill Award for contributions to

(*Continued on page 27*)

IAS Officers for 1959

STAFF OFFICERS FOR 1959

S. Paul Johnston, Director

Robert R. Dexter, Secretary

Joseph J. Maitan, Controller

PRESIDENT

William Littlewood

Vice-President—Equipment Research
American Airlines, Inc.

VICE-PRESIDENT

Clifford C. Furnas

Chancellor
University of Buffalo

VICE-PRESIDENT

Clarence L. Johnson

Vice-President—Research & Development
Lockheed Aircraft Corp.

VICE-PRESIDENT

I. Nevin Palley

Vice-President—Engineering
Temco Aircraft Corp.

VICE-PRESIDENT

Raymond C. Sebold (*left*)

Vice-President—Engineering
Convair, A Div. of
General Dynamics Corp.

TREASURER

Jerome Lederer

Director
Flight Safety
Foundation

Joan Roeburn, N.Y.

Newly Elected Members of the INSTITUTE COUNCIL

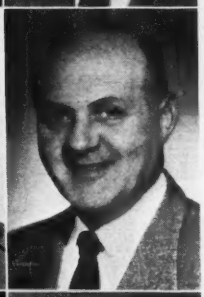
EASTERN AREA, 1-year term

Theodore E. Beck

Manager of Engineering
Fairchild Aircraft Div.
Fairchild Engine and Airplane Corp.

Clifford E. Roberts

Washington Representative
Boeing Airplane Co.



CENTRAL AREA, 1-year term

Col. Paul H. Dane, USAF

Professor of Thermodynamics
U.S. Air Force Academy

Milford F. Vanik

Chief of Technical Staff—Engineering
Wichita Div., Boeing Airplane Co.

WESTERN AREA, 1-year term

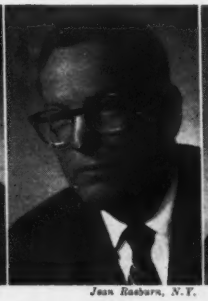
Dean R. Chapman

Aeronautical Research Scientist
Ames Research Center, NASA

M. C. Haddon

Director—Marketing
California Div.
Lockheed Aircraft Corp.

THREE-YEAR COUNCIL MEMBERS



Jean Raeburn, N.Y.

Milton U. Clauser

V-P & Dir., Physical Research Lab., Space Technology Labs., Inc.

George F. Douglas

V-P—Engrg.
Norair Div.
Northrop Corp.

L. Eugene Root

V-P & Gen. Mgr.
Missile Systems Div.
Lockheed Aircraft Corp.

William R. Sears

Dir., Grad. School of Aero. Engrg.
Cornell University

R. Dixon Speas

Pres.
R. Dixon Speas Associates

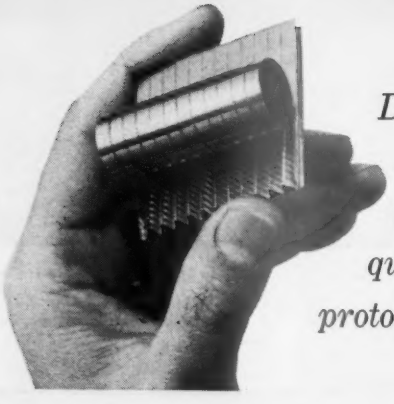
H. Guyford Stever

Prof., Aero. Engrg., & Assoc. Dean of Engrg.
M.I.T.

After 8 years of research North American introduces a low-cost Space Age material:

SPACE

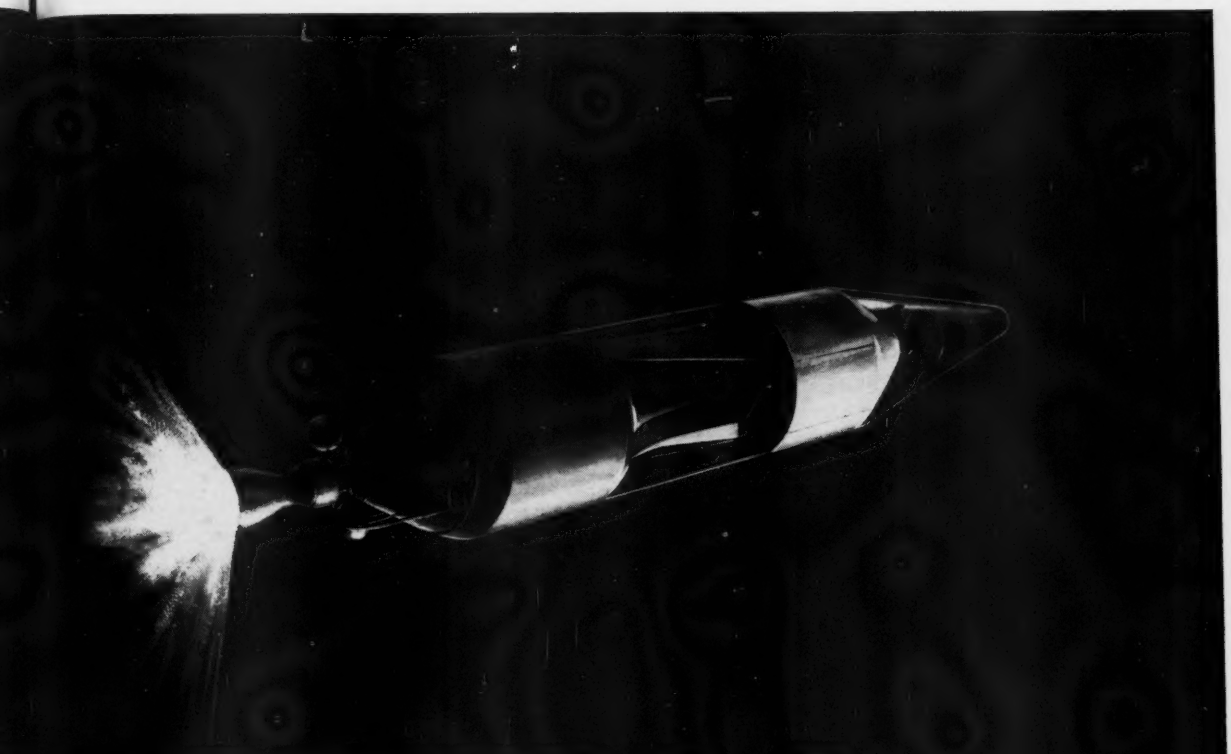
A WELDED STEEL SANDWICH



Designers may now obtain experimental quantities for prototype development

WHAT IT IS: SPACEMETAL is a stainless-steel sandwich with the light weight, high strength, and heat resistance required for Space Age missiles and planes. Inner sheet is beaded to form a V-shaped corrugation which allows rapid heat dissipation, permits hydrostatic testing for quality control. Yields weight savings (theoretical) as high as 75 percent over solid materials.

Manufactured by



EMETAL

H THAT'S BEING MACHINE-PRODUCED

HOW IT'S MADE: Production line machinery, developed by the Missile Division of North American Aviation, manufactures SPACEMETAL at the rate of 50 square feet per minute. The sandwich is now produced in 30-inch-wide panels, from type-301 stainless steel with a nominal gauge of 0.156 inches. Resistance welding eliminates excess weight of brazing or adhesive materials.

WHY IT'S STRONGER: SPACEMETAL's V-configuration core offers greater strength in one direction than usual honeycomb structure. SPACEMETAL is 235 times stiffer and can carry 23 times the bending load of solid type-301 stainless steel of equal weight. Beads along the sides of the corrugation double its crushing strength and improve other physical properties.

HOW TO GET IT: SPACEMETAL is available in experimental quantities to designers seeking its unique properties for application in missiles, supersonic aircraft, and related projects. Please write for complete information, outlining your requirements, to: SPACEMETAL, Dept. 496E, Missile Division, North American Aviation, Inc., 12215 Lakewood Blvd., Downey, Calif.

THE MISSILE DIVISION OF NORTH AMERICAN AVIATION, INC.

INSTITUTE OF THE AERONAUTICAL SCIENCES, INC.

Statement for the Fiscal Year October 1, 1957, to September 30, 1958

Consolidated Balance Sheet and Operating Statement

ASSETS

Unrestricted:		
Cash on Deposit	$173,582.99	
Accounts Receivable	27,344.19	
Advances on Intrafund Accounts	39,179.06	
Deposits and Prepayments	33,974.74	
Furniture and Fixtures	5,000.00	
Investments	554,695.85	
Total Unrestricted Assets		$ 833,776.83
Specific:		
The Sherman M. Fairchild Fund	$ 8,665.80	
The Flight Test Fellowship Fund	10,875.61	
The Guggenheim Fund	381,631.56	
The Louis W. Hill Space Transportation Fund	7,000.00	
The Paul Kollsman Fund	69,000.00	
The Vernon Lynch Award Fund	37,997.92	
The Minta Martin Aeronautical Student Fund	513,687.92	
The Sylvanus Albert Reed Award Fund	13,700.40	
The Lawrence Sperry Award Fund	13,540.87	
The Water-Based Aircraft Fund	20,487.73	
The Los Angeles Building Operating Fund	27,503.36	
The New York Building Maintenance Fund	103,989.29	
The Pacific Aeronautical Library Fund	22,022.04	
Total Specific Assets		$1,230,102.50
Facilities (at Cost):		
Los Angeles	$427,640.20	
New York	220,951.21	
San Diego (land leasehold)	176,706.11	
Total Facilities		$ 825,297.52

LIABILITIES AND RESERVES

Unrestricted:		
Accounts and Deposits Payable	$128,473.08	
Deferred Credits to Income	180,714.02	
Deferred Income—San Diego Building	8,623.84	
Deposit—Pacific Aeronautical Library	12,000.00	
Reserve Accounts	257,547.30	
General Fund—Balance September 30, 1958	246,418.59	
Total		$ 833,776.83
Specific Funds—Principal Balances		$1,230,102.50
Buildings, Land, and Equipment (see Assets)		$ 825,297.52

Statement of Income & Expenses

Income:		
Dues and Entrance Fees	$312,439.44	
Advertising Revenue	290,385.17	
Subscriptions and Related Accounts	177,705.56	
West Coast Buildings Revenue	43,917.99	
Dividends and Interest (unrestricted)	36,374.00	
Funds Administration	20,427.33	
Contracts Overhead Offset	11,906.04	
Miscellaneous	5,181.20	
Total Income		$898,336.73
Expenses:		
Publications	$424,798.22	
Salaries—Administrative, Clerical, & Accounting	177,182.16	
Libraries and Related Activity	105,255.57	
West Coast Offices	87,706.64	
Meetings and Travel	30,531.44	
Employees Retirement Fund & Social Security	27,620.55	
Printing, Postage, Communication, and Equipment	20,930.79	
Building Maintenance	18,004.11	
Office Supplies and Expense, Insurance	14,307.16	
Miscellaneous	6,482.92	
Adjustments charged to Capital Fund Reserves	(15,378.31)	
Net Expenses		$897,441.25
Net Income		$ 895.48

the field of space transportation. Furthermore, 1958 brought an increasing recognition of the need for continued critical analysis of the IAS organization and communicative processes if we are to continue to meet the challenge of our changing times.

1958 brought to the Institute a changing financial climate. Your capable staff met this immediate problem with effective action and with the necessary plans for continued stability of operating finances.

In each of these areas the Institute has met change with action, but to be fully effective for the future we must continue our action and our planning.

With Bill Littlewood as your President for 1959, you have leadership skilled in both planning and action, portending a great year for 1959 in Institute affairs.

With deep gratitude for the honor of serving as your President, and with sincere thanks to Members, officers, Council, and staff for the wholehearted support provided to me during my entire term of office, I am happy to turn over the duties of office to your new President and distinguished Honorary Fellow, William Littlewood.

EDWARD C. WELLS
President, 1958

Treasurer's Report—1958

THE PRESIDENT'S and Director's Reports indicate to you the scope of our activities for the year ended September 30, 1958.

All functions and activities of prior years were continued and in some cases expanded. New areas of service such as the International Congress of the Aeronautical Sciences, expanded student activities, and career development programs were absorbed in the overall IAS operations. The continuing general economic cost spiral combined with the readjustments familiar to all in the aero/space field required careful control of expenditures and utilization of the staff to maximum efficiency. This, together with an upward revision of Corporate Membership dues effective January 1, 1958, enabled the IAS to operate in the black by $895.48, after adjustments, for the year October 1, 1957, to September 30, 1958.

Advertising revenues in AERO/SPACE ENGINEERING and the AERO/SPACE ENGINEERING CATALOG declined substantially, but it is anticipated that the advertising situation will improve during the current year.

An increase in the JOURNAL OF THE AERO/SPACE SCIENCES subscription price from $4.00 to $5.00 to Members (nonmember cost is $15) has been put into effect to meet continually increasing printing and postage costs for the next few years.

The ARDC renewed its contract with the IAS to accumulate and provide technical aeronautical motion picture film information through June 30, 1959. The joint participation cost contract with AFOSR to provide the International Aeronautical Abstracts was also extended for one year.

Costs of the Los Angeles Building remained static. Auditorium usage, however, dropped from $24,000 to $14,000, resulting in an operational loss of $4,700 for the year. Pacific Aeronautical Library costs increased $8,000 without a commensurate adjustment in assessments to participants of this service. In both cases, the losses were charged against Capital reserves established to meet such contingencies. Ways and means to operate on a break-even basis are being surveyed.

The San Diego Building was leased effective January 1, 1958, for a 5½-year term to California Western University, the IAS retaining a portion for its use. In terminating most of the activities during the period October 1 to December 31, 1957, a cost of $2,600 was incurred which was charged against a Capital reserve previously accumulated.

A new account on the Balance Sheet is The Louis W. Hill Space Transportation Fund established to provide an honorarium of $5,000 annually for an outstanding contribution in the aero/space field. The Louis W. and Maud Hill Family Foundation has agreed to provide the funds necessary for the maintenance of the award for a minimum of 5 years.

Income from The Daniel and Florence Guggenheim Fund dedicated to international collaboration in the aero/space sciences was used to cover the costs of $38,000 in the preparation for and conduct of the ICAS Congress in Madrid last September.

Income totaling $20,000 from The Minta Martin Aeronautical Student Fund was utilized to underwrite student activities, including the seven Regional Student Conferences.

The preparation and distribution of meeting papers and special reports was accomplished under the aegis of The Sherman M. Fairchild Publication Fund. The total turnover was $17,000 for the year.

The market value of the Institute's portfolio was $2,002,000 in September which is $333,000 in excess of book value. All specific and general funds are now held in a Combined General Fund administered through the Finance Committee. The Chase Manhattan Bank is retained as investment counsel and custodian of all securities. The Lawrence Sperry Fund and The Sylvanus A. Reed Fund, whose investment assets were held separately, are included this year in the Combined General Fund. Transactions within the portfolio resulted in capital gains of $25,000 during the year which were reflected in the Investment Reserve account.

It is anticipated that operations for 1958–1959 will be at about the same general level as in 1957–1958. A balanced budget has been presented to and approved by the Council.

The books of account have been examined by Harris, Kerr, Forster & Co., Certified Public Accountants. A copy of their complete report is available to members for review at the national office.

R. DIXON SPEAS
Treasurer

Director's Report—1958

LATE IN 1958 a complete report of IAS activities over a 5-year period was compiled for the Council, distributed in full to all Sections, and published in somewhat condensed form in AERO/SPACE ENGINEERING (January, 1959). The report for the year 1958 which follows therefore omits background figures and is limited to the state of affairs as of the end of the past calendar year.

As will be noted from the Treasurer's Report, in spite of a serious shrinkage in our advertising revenues, we ended our fiscal year (September 30) in black figures. The "recession" in advertising income has continued into the current fiscal year, and steps are being taken to cut publication costs whenever possible. We are operating on a "balanced" budget, as approved by the Council, and the expectation is that operations can continue without deficit.

Membership

The membership picture continues to be good. Without "drives" or any special inducements or promotion, we have gained a net of 1,300 members during the year, the greatest single year's increase in our history. At year's end we were approaching the 15,000 mark, with students at 4,400 and expected to reach the 5,000 mark by spring. The breakdown, with the preceding 2 years for comparative purposes, is given in Table 1.

Meetings

During the year, the IAS conducted the following national meetings:

This Kidde ground service cart does everything from inflating a tire to starting a jet!

Weight: Approx. 150 lbs.
Dimensions: 40¾" x 22⅞" x 22¾".

Developed by Walter Kidde & Company, Inc., to meet aviation's need for a mobile, self-contained ground service cart, the Kidde unit shown above features a 4cfm compressor that delivers air from 50 to 5000 psi. It is equipped with moisture separator and chemical drier to reduce dew-point of delivered air to minus 65°F. Special relief valve prevents overcharging of the system, even if compressor is left running. The 1300 cu. in. air storage container for the Kidde Ground Service Cart may be either fiber-glass or non-shatterable wire-wound steel sphere. Ambient operating temperature is from minus 40° to plus 125°F. Available with either gasoline or electric drive, the versatile Kidde Ground Service Cart can be used for:

• Ground charging air bottles in missiles for fuel transfer and power actuation. • Ground charging of bottles used in pneumatic systems and fuel air combustion starters. • Servicing ground support and missile launching equipment. • Servicing landing gear shock struts and aircraft tires.

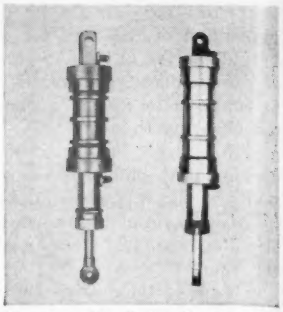
For more information on compact, efficient Kidde Ground Service Carts of varying capacities or for details on Kidde Pneumatic Systems and Components, write to Kidde today.

Walter Kidde & Company, Inc., Aviation Division
311 Main Street, Belleville 9, N. J.

Kidde

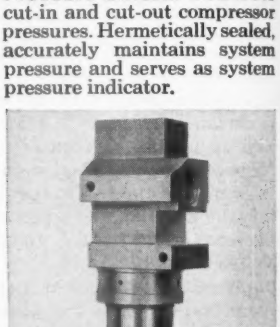
District Sales Engineering Offices: Dallas, Tex. Dayton, Ohio—St. Louis, Mo.—San Diego, Calif. Seattle, Wash.—Van Nuys, Calif.—Washington, D. C.

Walter Kidde-Pacific, Van Nuys, California
Walter Kidde & Company of Canada Ltd.
Montreal—Toronto—Vancouver

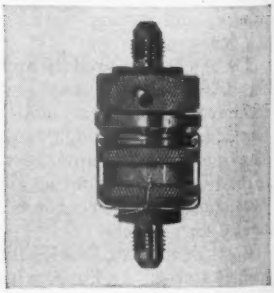


Pneumatic Actuators: High pressure, for use in hot gas servo systems or in afterburner nozzle area control and thrust reverser controls.

Pressure Switch: Controls cut-in and cut-out compressor pressures. Hermetically sealed, accurately maintains system pressure and serves as system pressure indicator.



Solenoid Valve: New one-half inch pilot-operated valve. Extremely fast response time (25 milliseconds) for use in systems involving pulsating, high pressure gases.



Quick Disconnect: Double-check — permits fast coupling or uncoupling of components without pressure loss. Has pressure check in both inlet and outlet unit.

TABLE 1
Membership—Comparisons by Calendar Year

	12/31/56	12/31/57	12/31/58
Temporary Honorary Members	15	16	19
Honorary Fellows	30	32	32
Fellows	202	213	215
Associate Fellows	1,041	1,240	1,475
MEMBERS	5,234	5,778	6,402
Associates	5,527	6,074	6,508
Subtotals	12,099	13,353	14,651
Student Members	3,908	4,274	4,400
Totals	16,007	17,627	19,051

Annual Meeting, January	New York City
Flight Propulsion Meeting, March	Cleveland
Summer Meeting, June	Los Angeles
Midwestern Meeting on Missiles	St. Louis
Astronautics Symposium (with AFOSR)	Denver
Specialists Meeting—Dynamics & Aeroelasticity	Fort Worth
Wright Brothers Lecture	Washington
Inspection Missile Test Center	Patrick AFB (USAF)
IAS/NADMC Symposium	Johnsville

In 1958 the IAS cosponsored the following meetings:

IAS/ISA/AIEE/ARS National Telemetering Conference	Baltimore
International Congress of the International Council of the Aeronautical Sciences	Madrid
CAI/IAS Joint Meeting	Ottawa
IAS/ARS Regional Meeting on Space Exploration	San Diego

We also participated in the following:

EJC Third Nuclear Engineering & Science Conference on the 1958 Nuclear Congress	Chicago
IRE National Aeronautic Electronics Meeting	Dayton
Heat Transfer & Fluid Mechanics Institute	Stanford University

International

The past year was marked by the successful operation of the First International Congress of the Aeronautical Sciences in Madrid, Spain, September 8–13. This meeting was held under the aegis of the International Council of the Aeronautical Sciences, whose Honorary President is Dr. Theodore von Kármán, and whose Executive Committee is headed by Maurice Roy of ONERA (France). Some 500 delegates from 25 countries attended. The next congress is slated for Zurich, Switzerland, in September, 1960. The entire project is supported financially by the Institute's Guggenheim Fund. Under the agreement with the Council, the Institute acts as the Secretariat.

During the fall of 1958 plans for the Seventh Anglo-American Congress were well along toward completion. This meeting is scheduled for October, 1959, with technical sessions to be held in New York City and field trips ranging from the New York area to Cleveland (NASA), and to Toronto where the operations will terminate. A meeting of leading aeronautical people in the New York area was held in December to plan for entertainment and plant inspections for the group while in the New York area.

During 1958 our close collaboration with the Canadian Aeronautical Institute was continued with a very successful joint meeting in Ottawa in October. The CAI will also cooperate with the Institute and The Royal Aeronautical Society in both the technical sessions and the field trips in connection with the Seventh Anglo-American Conference.

Sections

For the thirteenth consecutive year, all aspects of Section operation reached new highs (see Table 2). Section membership increased by over 1,000 in 1958. It continues to represent well over 85 per cent of total IAS membership. The number of section meetings increased from 320 to 350 in the past year. In 1958, the Sections continued to be the prime movers of IAS student literature and the sponsors of our regional student activities.

A new Section was organized in Central Florida and the Antelope Valley Subsection assumed independent Section status, increasing the total to 30. Negotiations are under way for the establishment of Sections in South Florida and Albuquerque. A new Subsection (of Los Angeles) was organized in the Channel Cities. The Daingerfield Subsection retains its status.

Eight issues of the Section Officers' *Newsletter* were published in 1958. There was expansion in both content and frequency of issue. Two meetings of Section Chairmen were held, one in New York during the Annual Meeting and one in Los Angeles during the Summer Meeting.

The Third Minta Martin Lecture was presented in 1958 at meetings involving the Boston, Washington-Baltimore-Hagerstown, and Los Angeles Sections.

Student Activities

Present student membership enrollment in 78 branches is 4,400, a new high. During 1958 S-A transfers were offered to 1,438 graduated student members; 818 accepted, a return of 56 per cent.

Three new student branches were established—one at Southern Methodist University, one at the Kellogg-Voorhis Campus of California State Poly in Pomona, and the third at Southwestern Louisiana Institute. An estimate of branch meetings held brings the total close to 700. Branch awards presented in 1958 numbered 104.

A *Faculty Advisor Newsletter* was begun, and copies of the first two issues have been distributed. Publication was begun of the *IAS Student Branch Newsletter* in March. Since then, six issues have appeared, containing, among articles of interest to IAS student members, 116 reports of branch meetings and inserts of "The Scientific Approach" by K. S. M. Davidson and "Aviation and Your Future" by A. T. Gregory. This publication is distributed monthly (except during the summer) to each student member.

The Flight-Test Engineering Fellowship was awarded to Henry P. Grudberg. The Fellowship poster-announcement was redesigned and distributed with applications for the 1959 award.

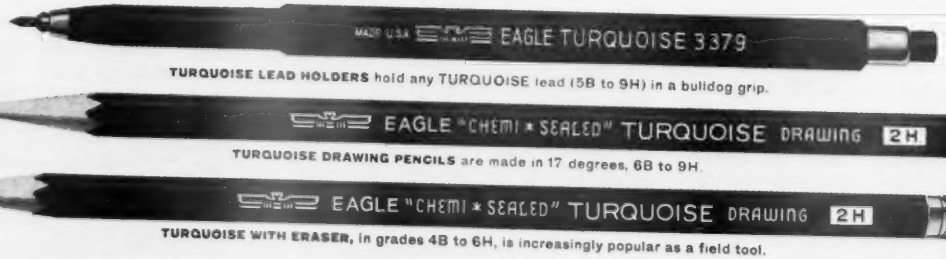
In the spring of 1958, seven Regional Student Conferences were held, one each in Ann Arbor, Mich.; St. Louis; Dallas; Atlanta; Los Angeles; University Park, Pa.; and Hoboken, N.J. Eleven technical papers which won first prizes in the 1958 Conferences were published in the *1958 First Award Papers;* 750 copies have been distributed to Sections, Branches, Corporate Mem-

TABLE 2
1958 Report—Sections and Branches

	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958
Sections	19	19	23	24	25	26	24	27	27	28	30
Meetings	121	126	144	168	181	237	241	267	275	320	350
Members	5,032	5,718	6,436	7,143	7,379	8,408	8,411	9,043	9,837	11,120	12,175
Branches	60	67	70	71	71	69	71	73	74	73	78
Meetings	327	336	317	323	350	319	366	227	313	319	700 (est.)

On any drafting material . . .

You draw sharper, clearer with Eagle Turquoise



TURQUOISE LEAD HOLDERS hold any TURQUOISE lead (5B to 9H) in a bulldog grip.

TURQUOISE DRAWING PENCILS are made in 17 degrees, 6B to 9H.

TURQUOISE WITH ERASER, in grades 4B to 6H, is increasingly popular as a field tool.

We've run tests on every drafting material made—including some that aren't even on the market yet! On all of them, TURQUOISE consistently out-performs other pencils.

Here's why: the strong TURQUOISE needle-point stays sharp longer. You get the world's cleanest lines—for the world's sharpest reproduction. TURQUOISE'S "electronic" graphite glides more smoothly (without skipping) over every material. And these superior qualities are combined with perfectly uniform grading—pencil after pencil!

So why switch pencils when you switch drafting surfaces? Standardize on Eagle TURQUOISE!

WANT A FREE SAMPLE? Write for a TURQUOISE lead, pencil, or pencil-with-eraser in the degree you'd like to test on your favorite drafting material. Eagle Pencil Company, Danbury, Conn.

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bers, the IAS Council, schools, libraries, and interested individuals.

Two National Awards (1957)—one Graduate, one Undergraduate—were presented in 1958. The two 1958 winners who have been selected will receive engraved plaques early in 1959. Duplicate National Awards were presented to the schools of the National winners.

A booklet detailing the *Ground Rules* of the IAS Regional Student Conferences was prepared and distributed to conference hosts and faculty advisers. A revised, illustrated edition of the *Student Branch Manual* was published and distributed in 1958.

Prints of the IAS film *Advance and Be Recognized* were automatically circulated to every student branch during the fall of 1958, in addition to its numerous other bookings made earlier by schools, sections, and conference hosts. The fourth and final edition of the *Giannini Film List* (38 pages, 300 films) was published in January, 1958; 930 film loan requests were handled, 480 serviced in 1958.

Publications

Two noticeable changes took place during 1958 with respect to Institute publications generally. The first was a continuing shrinkage in advertising revenue for the former AERONAUTICAL ENGINEERING REVIEW, and the second was a change in name for both the REVIEW and the JOURNAL. The two were not unrelated.

With the rise in competition for the advertiser's dollar due to curtailed defense budgets, and the rise of a group of new publications attempting to capitalize on the glamorous aspects of space exploration, it became obvious early in the year that some change in title of the REVIEW was desirable. The average advertising agency space buyer had been persuaded that any publication which did not have in its title the words "missiles," "rockets," or "spaceships" was out of date. This idea was fostered by the purveyors of the newer publications which had been started following the appearance of Sputnik I. After a great deal of study of possible combinations, the name of the REVIEW was changed in May to AERO/SPACE ENGINEERING in recognition of the fact that its content covered subjects ranging from airborne craft to space vehicles of all kinds. To call this to the attention of advertisers and advertising agencies, a unique direct mail device in the form of a model satellite-launching rocket was designed and executed by the late Hugh Judge of our staff.

It was recognized that a simple change in title would not solve the problem but every effort has been made to make the editorial content of the magazine consistent with its title.

Later, in order to indicate that the coverage of the Institute itself and of its JOURNAL also included papers on space technology, the title of the JOURNAL was shifted from the JOURNAL OF THE AERONAUTICAL SCIENCES to the JOURNAL OF THE AERO/SPACE SCIENCES.

To be consistent, the name of the AERONAUTICAL ENGINEERING CATALOG has also been changed to the AERO/-SPACE ENGINEERING CATALOG.

Because of the increasingly difficult problem of matching income to outgo in Institute publications, a reorganization of the department was effected in mid-1958. Responsibility for the editorial content of A/SE was transferred in full to Allan Bernhardt. He was promoted from Associate Editor to Editor in mid-summer. The Director of Publications, Welman A. Shrader, has thus been relieved of direct editorial responsibilities to permit him to concentrate on the overall economics of all publications. Not only has an additional sales representative been retained (see below under Public Relations) but a concentrated drive is under way to keep the ever-mounting publication costs down to a level commensurate with income.

During the course of 1958, publication of reports and preprints under the Sherman M. Fairchild Fund continued. Some 25,600 copies of all reports and 99 new titles were produced and distributed.

New York Libraries

Library activities during 1958 continued to grow as a result of an increase in the number of publications acquired and in response to demands from the IAS membership. Circulation of periodicals, reports, books, and papers rose 5 per cent over 1957. The greater portion of loans was made to Corporate and individual members of the Institute; the Pacific Aeronautical Library, the IAS staff, members of the American Helicopter Society, and large Governmental and university libraries accounted for about 20 per cent of the total. Reports, periodicals, and conference papers continued to outweigh books in the number of items borrowed. The photocopying service continued to serve the needs of the membership and the IAS staff.

Accessions and cataloging also showed increases during the past year. Approximately one third more technical and scientific reports were received as against the previous year, while the number of books acquired remained about the same. In the middle of the year, use of the ditto duplicating process was started, with resulting savings in time and effort. Over 8,800 catalog cards were prepared and filed, in addition to approximately 16,000 entries for current subject and author catalogs for abstracts appearing in AERO/SPACE ENGINEERING and another 5,000 cards for bibliographic aids received from outside sources.

The abstracting section, despite severe limitations in available printing space, was able to increase the number of published references to a total of close to 6,600 items. Reduction in type size and closer editing of abstracts were the principal means of achieving the increase in coverage. Abstracts from language source amounted to 25.5 per cent of the total of items abstracted, as against 15 per cent in 1957; 968 items from Russian language sources were covered, as compared with 368 in the previous year. Book annotations totaled 287. The publication of *International Aeronautical Abstracts*, which appears as a special insert in each issue of AERO/SPACE ENGINEERING, continued to receive support from the Air Force Office of Scientific Research of the Air Research and Development Command, USAF.

The valuable exchange of advance manuscript abstracts continued in effect between the IAS and the British Ministry of Supply office, charged with publication of *Index Aeronauticus*.

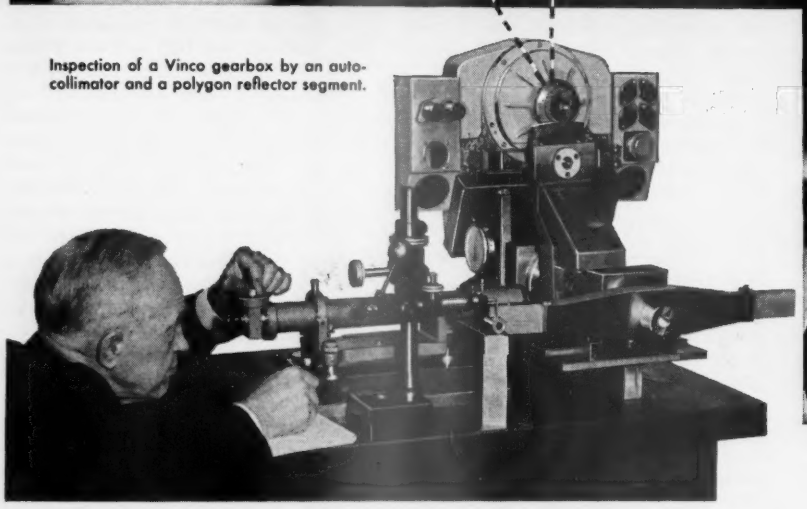
In May, 1958, the AERONAUTICAL ENGINEERING INDEX for 1956 was published. This volume contained more than 5,100 entries, arranged according to an expanded classification scheme, and included a *List of Periodicals and Reports*, an *Author Index* of 6,400 names, and an *Alphabetical Index to the Subject Classification*. By the end of August the first printing of 500 copies was entirely sold out, and a second printing of 300 copies was selling well as the year closed. For the first time since publication of the INDEX began, the entire edition was sold out within a period of 3 months and with production costs more than covered by sales receipts. This can be explained by three factors: (1) expanded sales promotion, (2) reduction of printing costs, and (3) increase in sales price to a realistic figure. By the end of 1958, all of the editorial work and the bulk of the production of the 1957 volume had been completed. The 1957 volume will have more than 8,600 entries and an *Author Index* of 8,100 names, in addition to a further expanded *Subject Classification* and *Alphabetical Index*. An edition of 800 will be printed to take care of the expected demand, a great deal of which is from overseas.

The reading room for technical literature continued to perform important services for organizations and individuals in the New York area. The number of visitors was almost twice the total for 1957.

The historical section continued to

MISSILES GEARED TO A STAR BY VINCO

Accuracy of 3.6 seconds of arc.
Gear ratio 2,584,800 : 1.



Inspection of a Vinco gearbox by an autocollimator and a polygon reflector segment.

Test stands for missile guidance systems include a gearbox built by Vinco to isolate the gyro system from the earth's rotation. Driven by an 1800 RPM synchronous motor, with a gear head stepdown to 1RPM, it produces an output motion of one turn in one sidereal day. Output accuracy limit of 3.6 seconds of arc reflects the action of 8 Vinco gears and 9 precision ball bearings. It is equivalent to .00018″ error of motion at the pitch line of a 32 diametral pitch, 20° pressure angle, 20.625 pitch diameter output sector.

Such accuracy is a must for checking the error or drift of gyroscopic and inertial guidance equipment. The gears in the sidereal rate test gearbox were ground and inspected on Vinco equipment by Vinco craftsmen. This personnel and equipment are available for producing gears of the same high precision for you.

The Vinco Optical Master Inspection Dividing Head is the most accurate instrument of its kind for checking angular spacing. Accuracy is guaranteed within a total variation of 2 seconds of arc (± 1 second). This instrument is available in both standard and heavy duty models.

VINCO CORP., 9111 Schaefer Hwy., Detroit 28, Mich.

serve the IAS executive and editorial staffs and many outside organizations in providing biographical, statistical, and historical information not easily available from other sources.

During the year the Librarian worked in association with other members of the newly formed National Federation of Science Abstracting and Indexing Services. In November and December of 1958, Mr. Glennon made a 5-week tour of Europe in order to visit libraries and information centers and to explore the possibility of expanded exchange of scientific and technical publications in the aero/space field. His visits included centers in the Soviet Union, as well as others in Western European countries.

Pacific Aeronautical Library

The Pacific Aeronautical Library is one of the most active technical libraries in the United States. Under the able guidance of Mrs. Nell Steinmetz, it operates substantially as an independent unit in the Los Angeles area, with its own Advisory Committee and its own budget. It does not carry a large inventory of books but handles a large load of technical reports and provides day-to-day delivery service of needed reports and technical publications to its subscribers in the Los Angeles area.

The following statistics will indicate the way the load has increased on this unit in the past 5 years:

	1954	*1958*
Number of plants serviced	34	54
Items catalogued	8,486	12,332
Items borrowed from outside sources	4,232	6,919
Requests for service	29,064	40,254

New Award

One important item was added to the list of available Institute awards during 1958.

In recognition of the part played by the Institute in the expanding area of space technology, the IAS was selected by the Hill Family Foundation of St. Paul to administer a substantial annual award for advances in space transportation. The details of this award were published in A/SE for October. Sufficient funds have been set up by the Foundation to cover the annual honoraria ($5,000–10,000 a year) plus administrative costs for a minimum of 5 years, with renewal contemplated if the results obtained are satisfactory to the Foundation and to the Institute. The Award Board met in Washington on December 15, 1958, and made the first award to Robert H. Goddard posthumously.

Facilities

Our planned program of continuous modernization and maintenance of all IAS properties was pursued during 1958. No major modification to any of our three buildings was necessary, but at the end of the year some shift was made in the arrangement of offices and lecture rooms to accommodate the expanding requirements of the Los Angeles NASA office.

During the latter part of the year a complete study of the Los Angeles facility was undertaken by the local Building Committee and the Los Angeles Advisory Management Committee. This study has to do with the future requirement in that area and the evaluation of the potential of the present building to meet these requirements. A complete report has been given to the Council and a sum of $10,000 has been authorized to permit more detailed study and to produce final recommendations.

During the year the San Diego building was largely occupied by offices and classrooms of California Western University under a 5-year lease agreement drawn up in 1957. The San Diego Section made use of the building on a scheduled basis under the lease agreement, and also the IAS Film Cataloging Unit (operating under an ARDC contract) occupied offices in the building.

Long-Range Planning

At the mid-year Council Meeting in Los Angeles, IAS President Wells appointed a long-range planning committee to take a look ahead and suggest appropriate ways and means to keep IAS objectives in phase with the rapidly changing times and techniques. The 5-year report mentioned above was put together by the staff for the use of this Committee. At the same time, the Director presented to the Council a recommended program for the reorganization of Institute operations, including proposed changes in the make-up and duties of the Institute's elected officers and of the Council. The intention is to broaden the base of representation in the Council and to establish better channels of communication between the membership at large and the management of the Institute. Both the Five-Year Report and the Director's recommendations were submitted to the membership (via the several sections) for comment and review. The results have been gratifying. Most sections have given serious thought and considerable study to the project and have responded with many useful suggestions. These have been passed along to the Committee and have been given full consideration in the recommendations which the Committee has made to the Council. Some of the changes proposed will involve modification of Institute By-Laws and Constitution and will, therefore, be referred to the membership at large for approval.

Public Relations

At the July meeting in Los Angeles, the Council recommended that we improve our public relations program to create a somewhat better relationship with the working press. The suggestion was made that the addition of an experienced man in this field might be helpful. About that same time it became evident that we needed someone on the West Coast to assist in the sale of advertising space in our publications in that area, and we were fortunate in being able to acquire a man who was experienced in both fields. John Ball, a writer, advertising salesman, and experienced airplane pilot, was added to the staff in November. He functions as Public Relations Manager to the national organization, as well as West Coast Sales Representative for AERO/-SPACE ENGINEERING.

* * *

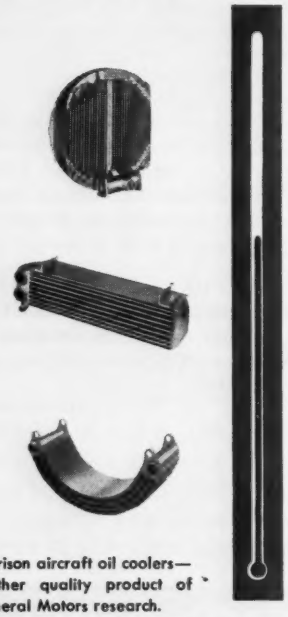
Although the demands on the staff have become increasingly heavy during the past year because of the large number of meetings and stepped-up activity in our sections and branches, the total number of people aboard has not been increased. This has meant that the pressure on all staff members during the year has been exceedingly high. I would like to take this opportunity to express my thanks to all of them for the effective and loyal support they are rendering to the Institute in carrying out its program of service to the aero/space industry and to the professional people whose efforts are making the space age a reality.

S. PAUL JOHNSTON
Director

Harrison Oil Coolers...

HALT HEAT ON THE HILLER

General Motors Controls Temperatures on New Lycoming-Powered Hiller Helicopter!



Harrison aircraft oil coolers—another quality product of General Motors research.

From take-off to touch-down . . . this versatile new Hiller 12E takes over, whether it's toting tons of cargo or on traffic control. And Harrison takes over the vital engine-oil cooling job! This hard-working 'copter, powered by the new Lycoming VO 540 engine, can carry 65 percent more payload 50 miles farther than its commercial predecessor. This takes cool power . . . *and plenty of it!* Harrison takes these strenuous temperature-control assignments in stride. Backed by nearly a half century of experience in the engineering, research and manufacture of top-quality heat-transfer products, Harrison heat exchangers are found on every type of aircraft from civilian planes to intercontinental jets. If you have a cooling problem, look to Harrison for the answer.

GM HARRISON

TEMPERATURES MADE TO ORDER

AIRCRAFT, AUTOMOTIVE, MARINE AND INDUSTRIAL HEAT EXCHANGERS

HARRISON RADIATOR DIVISION, GENERAL MOTORS CORPORATION, LOCKPORT, NEW YORK

Honorary Fellows for 1958

Honorary Fellows shall be persons of eminence in aeronautics and are elected by the Fellows and Honorary Fellows of the Institute residing in the United States. Not more than one person residing in the United States, nor more than one person residing in a foreign country, may be elected as Honorary Fellow in any one year.

AMERICAN HONORARY FELLOW
Charles S. Draper

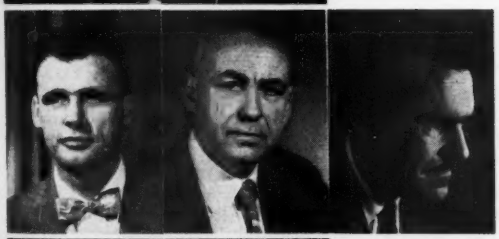
FOREIGN HONORARY FELLOW
Sir George Edwards

Fellowships in the Institute—1958

Fellows of the Institute of the Aeronautical Sciences shall be those who have attained a position of distinction in aeronautics and made notable and valuable contributions in one of the aeronautical sciences or aeronautical engineering.

- **A. M. Ballantyne**
  Secretary
  The Royal Aeronautical Society

- **Ralph L. Bayless**
  Chief Engineer, Convair (San Diego)
  A Div. of General Dynamics Corp.



- **Dean R. Chapman**
  Aeronautical Research Scientist
  Ames Research Center, NASA

- **R. R. Gilruth**
  Project Manager, Space Task Group
  Langley Research Center, NASA

- **Henry Görtler**
  Director, Inst. for Advanced Mathematics
  Albert-Ludwigs Univ., Freiburg, Germany

- **R. Greinacher**
  Section Chief (Aviation)
  Service Technique Militaire, Switzerland

- **Simon Ramo**
  Executive Vice-President
  Thompson Ramo Wooldridge Inc.

- **Homer J. Stewart**
  Director, Office of Progress Planning
  & Evaluation, NASA

- **Charles Tilgner, Jr.**
  Chief Aeronautical Engineer
  Grumman Aircraft Engineering Corp.

- **Karl D. Wood**
  Professor of Aeronautical Engineering
  University of Colorado

IAS Awards for 1958

Hubertus Strughold, M.D.
Professor of Space Medicine and Advisor, for Research, School of Aviation Medicine, USAF

The John Jeffries Award

This award honors the memory of Dr. John Jeffries, an American physician who, with Blanchard, the French balloonist, made the first aerial voyage across the English Channel in 1785, and on a previous flight made the earliest recorded scientific observation from the air. The award was established by the IAS in 1940 to give recognition to the importance to aviation of scientific endeavor in the field of medicine.

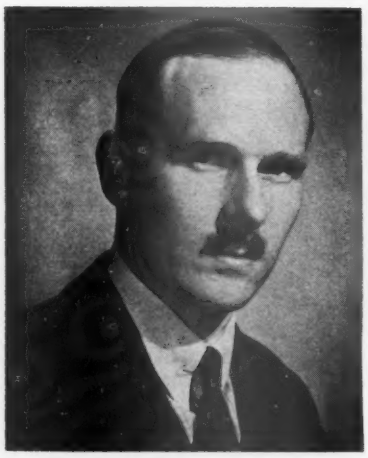
Presented to HUBERTUS STRUGHOLD, M.D.

"For outstanding contributions to the advancement of aeronautics through medical research."

Hubertus Strughold, M.D., Ph.D., born June 15, 1898, in Westtuennen, Westfalia, Germany, has distinguished himself as a tireless worker, prolific writer, and world authority in the fields of aviation and space medicine. Recipient of many honors, both in his native land and in his adopted country, Dr. Strughold has—in individual studies and writings and in other coauthored papers—contributed greatly to the store of knowledge of the environment that man will face, and must be able to survive, in the exploration of space.

It was early in 1929 that Dr. Strughold, who today is Professor of Space Medicine and Advisor for Research, School of Aviation Medicine, USAF, Randolph Field, Tex., began lectures in Aviation Medicine at the University of Wuerzburg, Germany. In 1935, after his appointment as Director of the Aeromedical Research Institute in Berlin, Dr. Strughold published his textbook, *Luftfahrtmedizin*. In 1946, he was appointed Director of the Physiological Institute of the University of Heidelberg; in 1949, Chief of the Department of Space Medicine, USAF.

Ever since the White House announcement on July 21, 1955—that the United States would launch an artificial satellite during the International Geophysical Year 1957–1958—a greater demand for knowledge of the meaning of space medicine and its application to this new mission has been made on Dr. Strughold as an international authority.



Patrick D. McTaggart-Cowan
Associate Director
Canadian Meteorological Service, Toronto

The Robert M. Losey Award

Established in 1940, this annual award honors the memory of Capt. Robert Moffat Losey, a member of the Institute and a meteorologic officer of the Air Corps, who was killed at Dombas, Norway, April 21, 1940, while serving as an official observer for the U.S. Army. He was the first officer in the service of the United States to die in World War II. The award carries an honorarium.

Presented to PATRICK D. MCTAGGART-COWAN

"In recognition of outstanding contributions to the science of meteorology as applied to aeronautics."

Patrick D. McTaggart-Cowan, Associate Director, Canadian Meteorological Service, Air Services Branch, Department of Transport, Canada, has—since 1947—been responsible for the reorganization of domestic service in Canada to better serve postwar aviation and for coordinating procedures with those established by the U.S. Weather Bureau to ensure the maximum uniformity for transborder operations. For the last two decades he has distinguished himself in many respects as a leader in the field of aeronautical meteorology.

Born in Edinburgh, Scotland, in 1912, Mr. McTaggart-Cowan was graduated with First Class Honors in mathematics and physics from the University of British Columbia in 1933. For his wartime services to the RAF Ferry Command, he was awarded the M.B.E. (Member of the Order of the British Empire) and, as a more general recognition, also received the Coronation Medal.

During the first half of World War II, Mr. McTaggart-Cowan established the meteorological organization for the delivery by air of aircraft to the United Kingdom. This included development of a publication of immense value to wartime transatlantic flying and served as a model for other theaters of operation.

In 1942, Mr. McTaggart-Cowan contributed greatly to production of the *Joint Control Instructions*, under which the aircraft operated in the North Atlantic Area. These rules became the foundations for current ICAO procedures.

XUM

Victor E. Carbonara
President
Kollsman Instrument
Corporation

The Sylvanus Albert Reed Award

The late Dr. S. A. Reed, designer of metal aircraft propellers and a Founder Member of the IAS, made an endowment to the Institute in 1933 to provide an annual award to be presented for a notable contribution to the aeronautical sciences, resulting from experimental or theoretical investigations which have had a beneficial influence on the development of practical aeronautics. The award consists of a certificate and an honorarium.

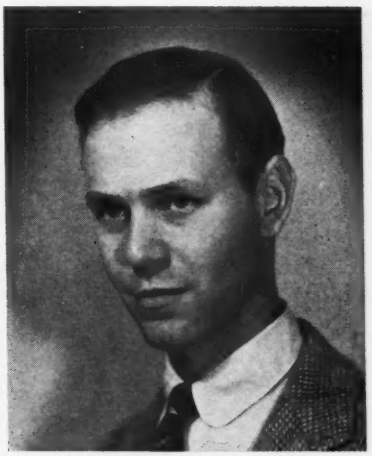
Presented to VICTOR E. CARBONARA

"For providing the basic engineering concepts and leadership in the development of automatic celestial navigation systems for aircraft and their integration in current weapon systems."

Victor E. Carbonara, President of Kollsman Instrument Corporation and a Director of its parent company, Standard Coil Products Co. Inc., has provided the basic engineering concepts for the first successful automatic celestial systems for aircraft. Through his leadership of a team of engineers, as Director of the Kollsman Research & Engineering Laboratories, a family of automatic navigation systems has been developed, two of which are in operation on the B-52 and B-58 bombers. The principles and techniques of these celestial navigation systems will be basic for the guidance of manned space vehicles.

A variation of systems developed under Mr. Carbonara's direction is designed for use in association with an important missile program; still another is being considered for application in undersea craft. Automatic star tracking and celestial data computer components developed under his supervision are being incorporated in terrestrial and space navigation systems by other research organizations.

Included among Mr. Carbonara's many other "firsts" is the octant, developed as early as 1928, and the periscopic sextant which now is used universally. He has been granted more than 42 patents covering navigation and flight systems, optical components, and scientific measuring equipment.



Robert G. Loewy
Chief Technical Engineer
Vertol Aircraft
Corporation

The Lawrence Sperry Award

This award was endowed in 1936 by the sister and brothers of the late Lawrence Burst Sperry, pioneer aviator and inventor, who was drowned in 1923 at the age of 31 after a forced landing in the English Channel. The certificate and honorarium are presented annually for a notable contribution made by a young man to the advancement of aeronautics.

Presented to ROBERT G. LOEWY

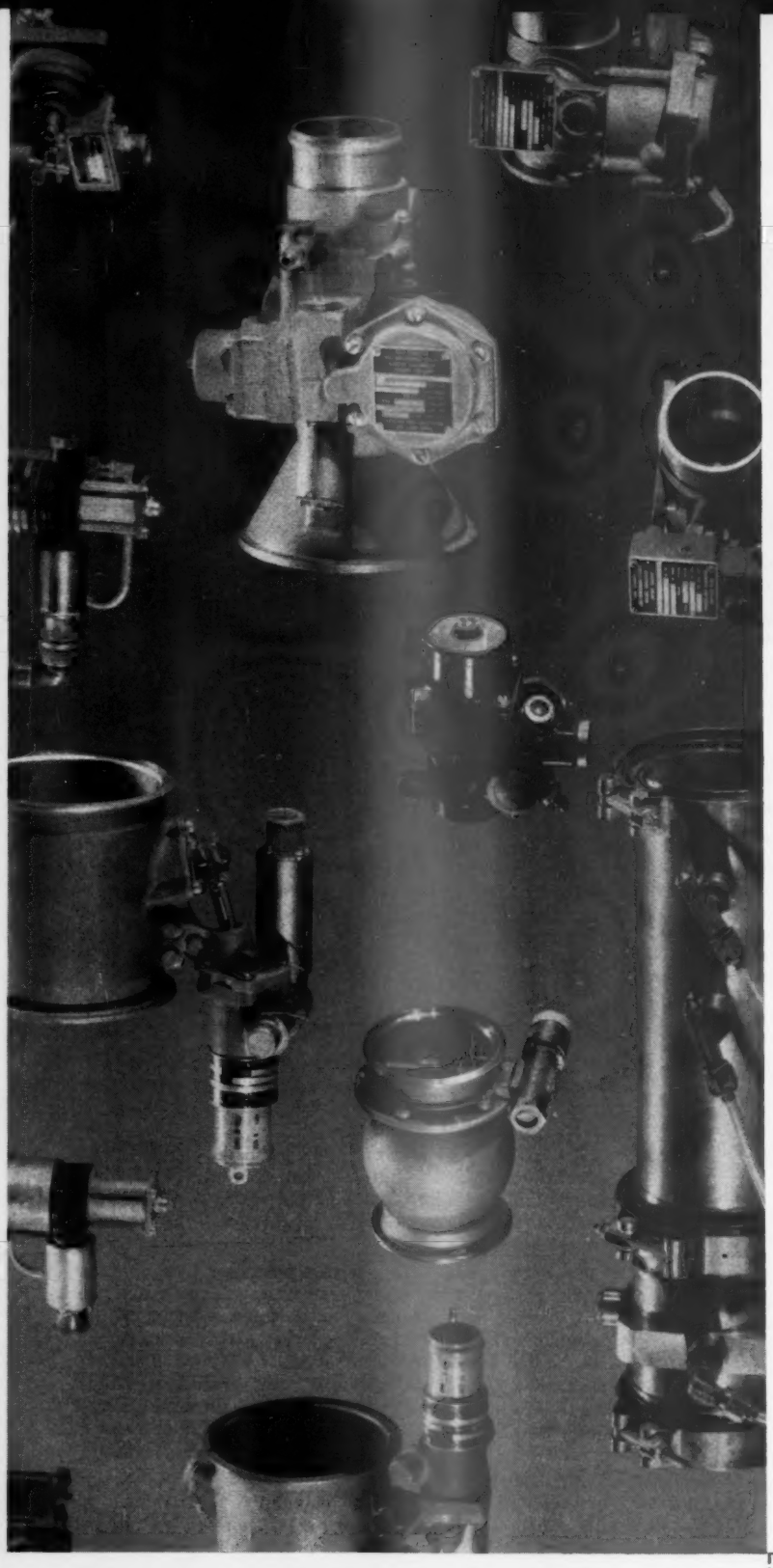
"For theoretical and experimental contributions to structural dynamics, aeroelasticity, and unsteady aerodynamics in a rotary wing aircraft design."

Robert G. Loewy in recent years has made original and important technical contributions resulting in (a) a better understanding of the highly complex rotary wing dynamics problem and (b) a successful design from aeroelastic and dynamic considerations of a radically new VTOL aircraft.

Specifically, Mr. Loewy in 1956 published a paper on the unsteady aerodynamics of rotary wings which showed that the classical nonstationary flow theory was completely inadequate for rotors and developed a new theory which demonstrated that nonstationary flow effects would be a major factor influencing rotor blade vibratory forces. Since these forces are of prime importance in determining the structural design and comfort level of helicopters, it is evident that this may be considered a major contribution to helicopter design theory.

Mr. Loewy executed a thorough analysis of the dynamics of a rotor-propeller and wing combination used as a basis for the design of the first tilt wing VTOL aircraft to be flown successfully and converted. Numerous other problems in aeroelastics, dynamics, stability, and control had to be solved before conversion was accomplished. Their successful solution makes him one of the outstanding young engineers in the aeronautical industry.

Mr. Loewy was graduated in 1947 from Rensselaer Polytechnic Institute with a Bachelor's degree in Ae.E. In 1948, he obtained his M.S. degree in Ae.E. from M.I.T.



reliable pneumatics unlimited

You can count on the reliability of Janitrol pneumatic controls for good reasons:

They are backed by a top-flight engineering organization equipped with the most advanced high-altitude test facilities for pneumatics and related hardware.

They are serving an impressive list of applications: RB-66, CF-105 (Mark I and II), C-130B, C-133, CL-28, F9F-8T, F11F, F-105E, P6M, Regulus I and the Goose missile.

A proposal for regulators or controls is backed by the same assurance of reliability as our proposal for your complete aircraft or missile pneumatic sub-system. Janitrol has the manpower, the know-how, the hardware, and the strength to deliver as promised. Your Janitrol representative welcomes the chance to meet with you.

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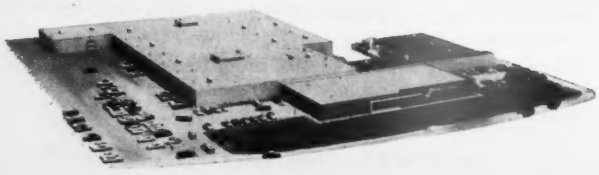


JANITROL

heat exchangers & combustion equipment for aircraft, missiles, ground support

IAS Awards (*continued*)

Joseph Tsu Chieh Liu

Robert H. Tolson

The Louis W. Hill Space Transportation Award

1959 marks the first presentation of this honor awarded to the late Robert H. Goddard, pioneer in rocket propulsion, and received by his widow, Mrs. Esther C. Goddard.

For complete details on this Award, made possible by The Louis W. and Maud Hill Family Foundation, readers are referred to the Editorial and Special Insert in last month's issue, pages 20–28.—ED.

IAS Minta Martin National Student Awards

The Minta Martin Aeronautical Student Fund was established by the late Glenn L. Martin in honor of his mother who encouraged him in his aviation pursuits. It is administered by the IAS to encourage aeronautical engineering education. This is accomplished in part through several annual regional student conferences where students have the opportunity to present original technical papers in competition for cash awards. From among the first-prize graduate and undergraduate papers of all conferences, national award winners are chosen by a board of eminent scientists and engineers. The winners receive engraved plaques for outstanding engineering achievement, duplicates of which are presented to their universities.

Presented to

JOSEPH TSU CHIEH LIU: Graduate Division
ROBERT H. TOLSON: Undergraduate Division

This year's Graduate Division winner, Joseph Tsu Chieh Liu, is an Engineer in the Advanced Heat Transfer Section of Propulsion Thermodynamics Systems Group, Convair-Fort Worth, Div. of General Dynamics Corp. He won the award for his paper, "The Laminar Boundary Layer Flow on an Axisymmetric Body with Transverse Curvative Effect," first-prize winner at the 1958 Southwestern Conference.

Mr. Liu, born in Shanghai, China, received a Bachelor's degree in Aeronautical Engineering and Mathematics from the University of Michigan in 1957. He received his M.S. in Aeronautical Engineering the following year.

Robert H. Tolson, the Undergraduate Division winner, is an Engineer in the Theoretical Mechanics Div., Langley Research Center, NASA. His paper that won the National Award, "Longitudinal Stability Derivatives of Missile-Shaped Bodies at Hypersonic Speeds" won first prize at the 1958 Southeastern Conference. He is a June, 1958, graduate of Virginia Polytechnic Institute with a Bachelor's degree in Aeronautical Engineering.

The awards were presented at the Twenty-Seventh Annual Meeting to Mr. Liu, Mr. Tolson, and Virginia Polytechnic Institute. Presentation of the award to the University of Michigan will be made by the Detroit Section of the IAS.

Three Corporate Members to Collaborate on Missile and Space Programs

Three major Long Island aircraft companies—Grumman Aircraft Engineering Corp., Republic Aviation Corp., and Fairchild Engine and Airplane Corp.—have announced a plan of mutual aid to get a greater share of the new missile and space programs.

Facilities of the three Long Island divisions will join whenever advisable on new astronautics projects. Each company will prepare its own proposals on projects of its own origination. When such projects provide an opportunity for the interchange of resources, resulting in a superior joint capability, the companies will collaborate on proposals for missile and space projects to the military services, the ARPA, and the NASA.

Guiding this combined-effort program will be a Space Projects Coordinating Committee consisting of two representatives of each company, with a team of top corporate and consulting scientists and engineering personnel serving in a scientific advisory role.

Three Members Assigned to Top Posts at Convair

Three IAS members have been assigned to new top posts at Convair, A Division of General Dynamics Corp.

August C. Esenwein (M), formerly Vice-President and General Manager of the Fort Worth plant, has been made Executive Vice-President with responsibility for control of internal operations of Convair's five divisions.

Elmer P. Wohl (A), formerly Director of Planning, has been named Vice-President of Planning.

Frank W. Davis (AF) has been made Vice-President and General Manager of the Fort Worth plant. He had been Chief Engineer there.

Robert H. Widmer, formerly Assistant Chief Engineer for technical design at the Fort Worth plant, was named Chief Engineer.

A/SE Editorial Adviser Author of Navigation Book

Brig. Gen. Peter C. Sandretto, USAFR, a member of AERO/SPACE ENGINEERING's Editorial Advisory Committee's Electronics Panel, is the author of *Electronic Avigation Engineering*, which is reviewed this month in the the Book Reviews Section.

General Sandretto is Vice-President and Technical Director of ITT Laboratories, International Telephone and Telegraph Corp.

The book deals with electronic devices applied to transport aviation, with emphasis placed on engineering principles of the systems described.

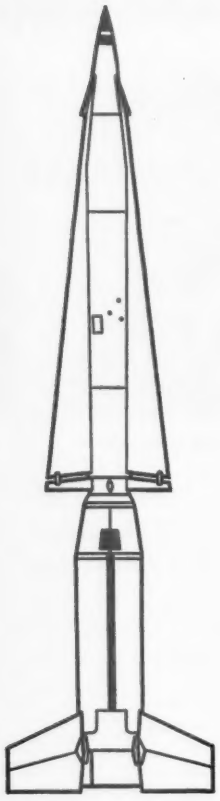
U. S. ARMY MISSILES

The man:

A U.S. Army missileman working with Nike Hercules missile equipment. The modern Army relies heavily on the special skills and knowledge of men like this who are trained extensively in military schools, and supported technically in the field by Army Ordnance Corps, Western Electric and Douglas field service men.

The mission:

Defense of U.S. cities. Army Nike Hercules units are already on duty at many key points...have the important assignment of guarding against enemy aircraft.



The missile:

Douglas-built Nike Hercules, product of a Douglas-Western Electric-Army Ordnance team, has successfully engaged supersonic drone targets at altitudes well over 60,000 feet. Other drone targets have been destroyed up to 100,000 feet, and at ranges beyond 75 miles.

Status . . . . . **Combat ready**
Range . . . . . **75 miles plus**
Speed . . . . . **Supersonic**
Warhead . . **Nuclear or conventional**
Service . . . . . **U.S. Army**

Depend on **DOUGLAS**

The Nation's Partner in Defense

News of Members

Raymond C. Blaylock (F), formerly Vice-President—Engineering, Chance Vought Aircraft, Inc., has been appointed to the post of Vice-President and General Manager. He has also been elected to the Board of Directors.

Gordon D. Brown (A) has been named a Vice-President of The Bank of New York, focusing his attention on aviation, transportation, leasing, electronics, and general industry. Mr. Brown joined The Bank of New York as an Industrial Specialist July, 1958.

Jack M. Cherne (M), formerly Project Engineer at Hughes Aircraft Division, has joined Vard, Inc, as Director of Engineering.

J. R. Clark (AF), formerly Chief Engineer—Aircraft Projects, was named Director of Engineering, Chance Vought Aircraft, Inc.

Starr J. Colby (M) has been appointed Assistant to E. P. Wheaton, Vice-President—Engineering, in charge of missiles and space systems program, Douglas Aircraft Co., Inc. He was formerly Supervisor of the Aero-Astrodynamics Section of the missiles and space systems engineering department.

Charles J. Daniels (M) has been promoted from Assistant Chief Engineer to Director of Government Projects of All American Engineering Co.

Lt. Gen. James H. Doolittle (HF), USAF Reserve, has assumed the chairmanship of the Board of Directors of Space Technology Laboratories. General Doolittle has retired as Vice-President of Shell Oil Co. However, he will continue to serve as a Director of the company.

C. Robert Gates (M), formerly of the Northrop Aircraft Corporate Development Planning staff, has been promoted to Director of Product Planning for the company's Norair Division.

Arthur C. Gilbert (M), formerly with North American Aviation, Inc., has been made Assistant Program Director, AN/AMQ-15 Air Weather Reconnaissance Program, at Bendix Systems Division, Bendix Aircraft Corp.

R. E. Honer (M) was named Assistant Chief Engineer—Electronics, Convair (San Diego), Division of General Dynamics Corp. He joined Convair in 1953.

J. Nelson Kelly (A) has joined the Fairchild Engine and Airplane Corp. as a Customer Relations Representative. He was formerly Division General Manager for Lear, Inc.

Frederick B. Lee (M), Director of Olin Mathieson Chemical Corp. and former Administrator of the CAA, has been elected to the Board of Governors of the Flight Safety Foundation.

Jules Kendall, formely Vice-President and General Sales Manager of Greer Hydraulics, Inc., has formed the Kenett Corporation—representatives and distributors of valves and hydraulic and pneumatic components. Mr. Kendall becomes President of the firm.

Arthur Nutt (F), Vice-President of Engineering, Lycoming Division, Avco Research Laboratory, Stratford, Conn., retired January 15. Dr. Nutt, however, is continuing to serve the division in the capacity of consultant.

Carl Orta (A) is now Research Engineer in Preliminary Design Missiles and Spacecraft at Lockheed Aircraft Corp. He formerly held the same position in the Flight Test Division.

William K. Rey (M), Associate Professor of Aeronautical Engineering, University of Alabama, was elected Grand Vice-Regent of Theta Tau, national professional engineering fraternity.

J. Louis Reynolds (M) has been elected Vice-President and Assistant to the President, Marquardt Aircraft Co. His new responsibilities will include developing and coordinating objectives and plans for the corporate marketing program.

Ira G. Ross (AF), President of Cornell Aeronautical Laboratory, Inc., has accepted the chairmanship of the new Research Division of the American Ordnance Association, one of thirteen technical divisions which render voluntary advisory guidance to the United States defense forces.

Robert L. Schroeder (A) has been promoted to the position of General Sales Manager of the Bedford (Cleveland, Ohio) Division of Pesco Products Division, Borg-Warner Corp. He was formerly aircraft Sales Manager of Pesco Products Division.

Frederick W. Schwartz, Jr. (M), formerly Management Consultant with Booz, Allen & Hamilton, has been appointed Chief Engineer, Union Tank Car Co.

Benjamin G. Holzman, new Commander of AFOSR and recipient of the IAS Robert M. Losey Award in 1947, is shown at left receiving his Brigadier General's star from Lt. Gen. S. E. Anderson, Commander, ARDC. Gen. Holzman succeeded Brig. Gen. H. Franklin Gregory, who retired on October 31. His new rank was effective as of that date, though he was not aware of his promotion until the ceremony pictured took place on November 21 at the Major Air Commanders Conference at Patrick AFB, Fla.

Melvin N. Gough (F), Head, Flight Research at Langley Research Center, NASA, for the past 16 years, has been assigned Director of NASA Activities at the Atlantic Missile Range, Cape Canaveral, Fla. Mr. Gough is a member of this magazine's Editorial Advisory Committee and serves on its Space Technology Panel.

Dr. Allen E. Puckett (F), 1949 winner of the Lawrence Sperry Award as the outstanding young man in aeronautics, has been named a Vice-President and Director of the Systems Development Laboratories of Hughes Aircraft Co.

Attention Members!

All members of the Institute are invited to submit material concerning their activities for publication in the "News" columns of *Aero/Space Engineering*.

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Necrology

Col. William G. Brown

Colonel William G. Brown, USAF, a Fellow and Founder Member of the IAS, died September 25 in Weisbaden, Germany. Colonel Brown had been a military scientist, instrument pioneer, and college professor during a career that covered 37 years of aviation experience.

Last July he accepted a position as Director of the Training Center for Experimental Aerodynamics under NATO in Brussels. From 1953 until his retirement in November, 1955, he was Director of Research at the Wright-Patterson AFB in Dayton, Ohio.

He began his aviation career after receiving a Bachelor of Science degree in physics and a Master of Science degree in aeronautical engineering from M.I.T. He headed instrument and development work for the Navy and helped make the first accurate measurements of the loads encountered by airplanes in flight.

From 1920 to 1924 he was in charge of flight tests and instrument design for the NACA. He was Assistant Professor of Aeronautical Engineering at M.I.T. from 1924 to 1929. In 1927 he entered the Air Force Reserve. He was Professor of Aeronautical Engineering at Louisiana State University from 1933 to 1940. During the war, he served as a liaison officer with the National Defense Research Committee, Office of Scientific Research and Development, National Inventor's Council, and the Interdepartmental Committee on scientific personnel, all in Washington. After the war he spent 6 years with the Research and Development Board.

In his work he had been associated with Orville Wright, Lt. Gen. James H. Doolittle, Dr. Vannevar Bush, and Charles F. Kettering.

Hugh C. Judge

It is with deep regret that the Institute announces the loss of one of its most capable staff members and IAS Associate. Hugh C. Judge, who passed away on January 30, was the "idea man" who designed and produced most of the promotional material, pamphlets, and art work published by the Institute. As Business and Production Manager of all IAS publications, he was responsible for many of the improvements in appearance and format so evident in AERO/SPACE ENGINEERING today.

Hugh first came to the IAS in August of 1940 as aide to the Secretary to the Manager of the AERONAUTICAL ENGINEERING REVIEW and was responsible for advertising production.

He served for 3 years overseas with the 316th Air Depot Squadron, the 100th Airdrome Squadron, and the 910th Air Engineering Squadron, attached to the 8th and 9th Air Forces. He returned to the IAS early in 1946. In January, 1957, after several promotions, he assumed responsibilities held at his death.

Hugh was a native New Yorker, born on December 25, 1920, to Mrs. Frederick B. Judge and the late Mr. Judge. His early years were spent in Jamaica, L.I., where he attended Richmond Hill High School. He studied art and advertising design and layout at the Art Students League and the New School for Social

Hugh C. Judge

Research, and advertising administration through the Advertising Club of New York. He was married to the former Miss Elda Schiaroli, of Waterbury, Conn., and lived in Rego Park, N.Y., in recent years.

Major Gen. Clements McMullen

Major Gen. Clements McMullen, USAF (Ret.) (AF), who rose from Army private to an Air Force career as pilot and administrator, died January 10 of a heart attack. He was 66 years old.

A civil engineer in Florida from 1912 to 1917, General McMullen enlisted in the Army in World War I and was assigned to technical training as an air cadet. At national air races in St. Louis in 1923, he won the Liberty engine trophy race in what was described by newspapers of that day as "the amazing fast time of 139 miles an hour."

On a flight from New York to Buenos Aires in 1930 with Lt. Will W. White, General McMullen set a long-distance speed record of 52 hours, 30 min., in the air.

He spent most of World War II as Commanding General of the Far Eastern Air Service Command. At his retirement in 1954, after 37 years of military service, he was Commander of the San Antonio Air Material Area.

John E. Younger

Dr. John E. Younger (F), Head of the Mechanical Engineering Department at the University of Maryland, died December 30. His age was 66.

Dr. Younger received the Spirit of St. Louis Gold Medal award in 1941 given by the ASME every 3 years for "meritorious service in the advance of aeronautics."

Before coming to the University of Maryland in 1938, Dr. Younger taught at the University of California.

He received a B.S. degree in 1923, an M.S. in 1924, and a Ph.D. in 1925 from the University of California.

IAS News — Corporate Member News

• **Aerojet-General Corp.** has named Dr. A. L. Antonio Vice-President, Chemical Division. Dr. Antonio directed Aerojet's solid-propellant research and development between 1944 and 1954. Fred Hall, former Governor of Kansas, has been named Director of Management Control for the Solid Rocket Plant.

• **American Bosch Arma Corp.** has appointed two Assistant Chief Engineers at Arma Division. They are Dr. Bernard Litman, Assistant Chief Engineer for Research, and Wen Tsing Chow, Assistant Chief Engineer, Missile Guidance.

• **Douglas Aircraft Co., Inc.,** has created two major functions within its newly established weapon systems organization. These are Marketing and Requirements, with Alfred V. Guillou as Manager, and Plans and Programs, with Peter Horton as Manager.

• **Fairchild Engine and Airplane Corp.** has elected Richard S. Boutelle Vice-Chairman of its Board of Directors.

• **The Garrett Corp.** . . . AiResearch Aviation Service Division has acquired a 9-acre section of property for expansion of its facilities at Los Angeles International Airport.

• **General Dynamics Corp.** . . . Stromberg-Carlson has appointed George A. Franco Manager of the Radio Communication Laboratory, Research and Advanced Development Div.

• **General Motors Corp.** . . . Delco-Remy Division has named Vice-Adm. Truman J. Hedding, USN (Ret.), Technical Assistant to General Manager Donald L. Boyes, serving as executive representative on defense programs.

• **International Business Machines Corp.** has elected Robert C. Ransom as Assistant Secretary.

• **Johns-Manville Corp.** has entered the fiber glass industry by its acquisition of L. O. F. Glass Fibers Co., Toledo, Ohio. All assets and the going business of the Toledo firm have been transferred to Johns-Manville Fiber Glass, Inc., a newly organized and wholly owned subsidiary.

• **Koppers Co., Inc.,** Metal Products Division, has named Nicholas Kay Division Vice-President of Koppers Co.,

(*Continued on page 120*)

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PROFESSIONAL NOTES AND REPORTS

Engineering and Scientific Briefs from Correspondents Around the Globe

Automation on Increase in U.S.S.R., Periodicals Say

♦ Two items noted in recent U.S.S.R. periodicals exemplify increasing Soviet adoption of automation in industrial work.

One report concerns an electronic computer intended to maintain constant and specified mean power of the electrical furnace used in high-quality steel making. The device allegedly assures high-quality metal and reduces production costs.

Successful testing of the prototype, it is stated, led to development of an electronic computer for adjusting the service regime of arc furnaces for ferroalloys.

The other item announces that, in Dnepropetrovsk, specialists in instrument design and construction have produced a gamma-electronic relay which permits remote control of various machinery.

West German Paper Reports on New Soviet Interceptor

♦ In mid-1958, a new Soviet interceptor aircraft was observed near a Soviet airport in the vicinity of Graudenz, Poland, according to a West German newspaper account. Unofficial sources are said to have identified the new plane as the MIG-31.

The reporter states: "The extremely large craft climbs rapidly, and its maximum speed is estimated at Mach 2." He comments that the low aspect ratio and the high side fin of this new delta wing prototype are characteristic of Soviet design. The power plants are arranged in tiers in the tail section similar to the English Electric P1, he adds, and the air-intake ducts are located laterally on the fuselage well in front of the wings and have peculiarly shaped diffusion cones. Informed persons reportedly have stated that the MIG-31 is the first Soviet aircraft in which the area rule has been applied.

Kazakh Academy Allocated Land; Laboratories Planned

♦ According to a Moscow news item, about 450 hectares of land have been set aside in a picturesque spot near Alma-Ata, capital of Kazakhstan, for the Nuclear Physics Institute of the Kazakh Academy of Science. Here the first nuclear reactor in Kazakhstan will be set up.

There will also be laboratories of nuclear power engineering, neutron physics, nuclear reactions, and transistors.

New Research Center Being Built in Irkutsk

◆ The *Moscow News* announced in June that a second Siberian research center is being built in Irkutsk. The educational and research institutes of electrochemistry, metallurgy, biochemistry, geology, geography, and biology will cover an area of 200,000 hectares. Botanical gardens will also be laid out.

A residential area with a total floor area of 77,000 sq.m. will be built for the scientists and other personnel of the center. It will have its own schools, kindergartens, nurseries, shops, canteens, laundries, a clinic, and a hospital.

First Television Telescope in Use at Leningrad Observatory

◆ Out of Hungary comes a report that a television telescope is being used in an astronomical observatory near Leningrad. M. Kuprevics, chief scientific staff member of the Leningrad Institute is given credit for construction of the apparatus. The television telescope, as described, contains a 20-m.-focal-distance telescope to which an extremely sensitive television receiver is attached. The heavenly body being observed with the telescope appears on the television screen.

During observation, three television sets work simultaneously. One controls the focus adjustment, the second checks the quality of the projection, and the third produces a photographic record by means of a special electronically operated shutter.

Miniature Pneumatic Computer Built in U.S.S.R Science Laboratory

◆ According to a report from Hungary, a pneumatic computer has been developed in the laboratory of the Institute of Automation and Telemechanics, Academy of Sciences, U.S.S.R. The apparatus is smaller than "an ordinary school inkwell" and has no radio tubes, condensers, or resistors. Power is supplied by compressed air. The computer adds, subtracts, multiplies, squares, extracts the square root, integrates, and performs differential calculus.

Russian Language Institute Will Be Headed by Vinogradov

◆ A Russian bulletin announces that, in view of the growing world importance of the Russian language and of the tasks of a further growth in Russian language culture, the Presidium of the U.S.S.R. Academy of Sciences has decided to set up a special Russian Language Research Institute, based on the Russian sectors of the Linguistics Institute of the U.S.S.R. Academy of Sciences.

The structure of the Russian Language Research Institute and the staff of its scientific council have been approved. The council will be headed by Academician V. V. Vinogradov.

Hungarian Factory Readied to Produce Extruded Plastics

◆ Under a June dateline, a Hungarian industrial journal announced that preparations were almost complete at the Hungarian Plastics and Chemical Factory for producing "Caprolactam" and the polyamide materials derived from it. Machinery was to be installed soon and production to begin on polyamide extrusion material and polyamide foil in the second half of the year.

The Hungarian-developed polyamide synthetic fiber "Danulon" will be produced from "Caprolactam," the report stated. It was added that the factory will also produce cogwheels, bearings, various parts for textile machinery, and similar articles from the extremely resilient, nearly unbreakable, tough, heat-resistant polyamide extrusion material.

New University Planned by Soviets in West Siberia

◆ The fortieth State University to be established in the U.S.S.R. will be functioning in Novosibirsk by the autumn of 1959, it is announced. Novosibirsk, in Western Siberia, near the junction of the Trans-Siberian Railroad and the Ob River, has been prominent in the news in recent months because of the large scientific center mushrooming there.

GUEST EDITORIAL

By Vice Adm. Selden B. Spangler, USN (Ret.)

Let's Start the Difficult Now!

"Science is a habit of mind, a sensitive awareness of the physical world which, with enough hard work now and then, leads to new concepts or new combinations of old concepts."

Drawing from the above definition by the late Dr. Kenneth Davidson, stated in a Guest Editorial published posthumously by Aero/Space Engineering last November, Admiral Spangler compares the research scientist and the scientific researcher and sees tasks of some magnitude ahead.

Dr. Davidson's image with which we all agree, or most certainly should, is one that many of us have described time and time again in different ways. However, in the rediscovery of science and scientists which has taken place since Sputnik, I find that there is a tendency to confuse terms to an extent that influences both public opinion and embryo scientists toward concepts not in accord with this definition. This was true in pre-Sputnik days, of course, perhaps to even a greater degree; but, in these days when science has an opportunity to advance itself in the public's opinion, it is most unfortunate that any confusion in terms is allowed to persist.

Specifically, what I am intending to imply is that there is a wide difference between a research scientist and a scientific researcher. To me, a scientist is a person eternally interested in every phenomenon he observes and eternally curious as to its explanation in scientific terms, whether it be the curve of the ball hit by the average golf duffer or the unexpectedly wide band of cosmic radiation which seems to surround the earth. Of open mind, he immediately attempts to explain an observed phenomenon to his satisfaction by the application of his own personal ideas and experiences and those of all others which have become available to him through a persistent and interested survey of technical opinion. Upon the discovery of new ideas or principles, he immediately seeks application of them to the solution of problems that may have bothered him for years. An unsolved problem is to him an everlasting challenge. As a researcher, the true scientist is not at all bothered by the fact that he may start out to solve a given problem or explain an observed phenomenon only to discover that he has arrived at a solution to a wholly foreign problem or has discovered an avenue of approach to the explanation of a quite different phenomenon. His goal is always to add to the general fund of information that underlies all scientific achievement. Thus he is not above presenting his solutions to the world's political difficulties, as well as scientific problems—despite adverse criticism or even ridicule on the part of the politician and the general public, swayed by the spellbinders who seem to control public opinion to a major degree. It is fortunate indeed for the future of the world that the true scientist cannot condone intellectual dishonesty; it is most unfortunate at times that the world does not recognize and accept this an as essential attribute of science.

The scientific researcher, on the other hand, is—certainly not always, but all too often—a person who refuses to deviate from a path straitened by his personal knowledge and experience and who has no desire, and actually resists any attempt, to broaden his interests. In some cases this stems from intellectual cowardice, a reluctance to chance a foray into fields outside his immediate experience. His persistence in his research may, and quite often does, result in a solution to his problem which he cannot or will not recognize as

Formerly Commander of the Naval Air Development and Material Center at Johnsville, Pa., Admiral Spangler is now Director of Research, The Garrett Corp.

an answer simply because, if he does, his world will come tumbling about his ears. He may obtain a 98 per cent solution, but he will thereafter strive for the rest of his life to achieve the remaining 2 per cent, simply because all the rest of science is alien to him and therefore frightening. One cannot help but admire his tenacity of purpose but at the same time abhor a state of mind which denies to the world any share, however small, of its intellectual capabilities. I certainly do not want to leave the impression from this discussion that I do not honor the dedicated researcher, since a substantial part of the world's progress has been due to his efforts. I am rather inveighing against the researcher who need not wear blinders but does so from choice, against the one who has the capabilities of becoming a scientist but does not do so, whatever the reason.

Unfortunately, the world often does not recognize such a distinction between the scientist and the researcher, and, in fact, uneducated opinion all too often classifies the scientist as a person of narrow, restricted view almost by definition. Unfortunately also, this point of view is frequently fostered by educators who teach the principle that a Jack-of-all-trades is a master of none, even though a general handyman is quite often a more valuable man to have around the house than an expert cork tile layer. It is unquestionably true that any scientist should have become adept in some specific field to the point of proving to himself his competence and thereby giving himself confidence in his judgment, but even this result is more readily achieved through a familiarity with related or comparable fields The electrical analogy for the equations of motion was not developed by an expert in condenser design.

Our whole economy, and naturally therefore our school system, is geared to recognize calculable quantity rather than intangible quality of effort. Even in our graduate schools, a thesis that does not demonstrate something positive is quite often considered unsatisfactory. I was quite amused recently when a successful candidate for a Doctor's degree was told to rewrite his thesis description because it contained only 60 pages whereas 100 was more usual. As a nation we are often accused of producing fewer scientists percentage-wise than do other nations. If this is true, is it not due to our insistence on quantitive results and our insistence on gearing our curriculums through the first years of college to the below average student? We permit only minor deviation from the standard, and any attempt to provide special treatment for the promising prospective scientist is always violently resisted on the grounds that this would not provide equality of treatment for all and would result in a scientific aristocracy. One of the principal characteristics of the true scientist is humility; he would be the last to try to set up an aristocracy of any kind, whether of politicians, labor leaders, or scientists. It seems to me the solution is reasonably apparent. We do not need to increase the quantity of our education; more mathematics, more homework, more this, more that, these are not the answer. We do not need to reduce the educational opportunities of the average student, but we do need to recognize the principle that we should teach our most promising students to be eternally curious about everything, to seek out answers for themselves, and to think things through with the help and advice of the instructor as needed. We need to reaffirm unselfish dedication of purpose as a prime virtue rather than the act of a dupe. For the prospective scientist we need to make education an exciting adventure, not an act of drudgery. There are those that advance the ancient Hebraic theory that discipline is good for the soul and conclude from this that a 10-hour school day is the right thing for any student—again, of course, putting a premium on quantity rather than quality of effort. Perhaps this tenet is applicable when we are considering amenability to the law, but this kind of thinking indicates a lack of understanding of the character of a scientist. The true scientist is a wholly dedicated altruist, and there is no possible way of imposing on him a discipline more severe than he imposes upon himself. Somehow there never seems to be enough hours in a day, or days in a year, or years in a lifetime.

Doctor Davidson wrote that it would require a generation to achieve a body of trained scientists capable of accelerating the rate of scientific discovery. Perhaps so. We can all agree that it is an undertaking of considerable magnitude, regardless of whether we agree with his estimate. However, let us not draw back from initiating action simply because the task seems difficult. We must start somewhere, sometime. Why not here and now?

✦ ✦ ✦

The weight of a representative transport aircraft utilizing a blown flap installation to attain STOL performance is compared with that of an aircraft of similar performance having an unblown flap and a larger wing. The former is shown to have the larger payload capacity for equal gross weights when the design stall speed is less than 40 knots. Some design conditions most favorable for the blown flap installation are indicated in the discussion.

Blown Flap System for STOL Performance

Weight Considerations

Milton Schwartzberg
The Martin Company

THE MILITARY and economic advantages inherent in the use of aircraft types capable of operating from and landing on runways of very short length have been appreciated for many years. A number of schemes involving either the use of boundary-layer control techniques or oversized lifting surfaces have been developed within the past several years to attain the high lifts required for efficient short take-off and landing (STOL) performance. Among these is one, made possible by the development of turbojet and turboprop engines with high thrust to weight ratios, which appears to offer exceptional possibilities for the realization of practical STOL aircraft. The method in question relies on the fact that the lifts required for STOL operations can be attained by blowing high-velocity air or jet-engine exhaust gases over an aircraft's deflected trailing-edge flaps during take-off and landing. This particular technique is currently under development at The Martin Company.

The major advantage of the "blown flap" technique is that it obviates the use of oversized lifting surfaces with their detrimental effect on aircraft speed.

The advantages of the blown flap system notwithstanding, the designer must consider its application in terms of a particular aircraft's performance requirements. One of the pertinent questions to be considered is the effect of the blown flap system installation weight on overall aircraft weight and, in particular, its comparison—in this respect—to that of an efficient "unblown" high-lift flap installation. The question must eventually be resolved for each individual design on the basis of its own particular characteristics. However, it is nevertheless possible to formulate a somewhat generalized solution which can indicate whether or not a blown flap system would be worthy of consideration for a specific application.

The author is Design Specialist, Aerodynamics.

SYMBOLS

A	= aspect ratio
B	= factor used in equation for flap blowing momentum coefficient
C	= constant denoting product of wing area and wing drag coefficient
C_{D_0}	= minimum drag coefficient
$C_{D_{0_w}}$	= wing minimum drag coefficient
C_L	= lift coefficient
C_μ	= blowing momentum coefficient, $m_j V_j / qS_{af}$
c	= wing chord
D	= drag
e	= wing efficiency factor
K	= constant denoting product of wing area and aircraft drag coefficient (excluding wing)
K'	= constant used in formula for wing weight; dependent on wing planform and thickness and load factor
L	= lift
m_j	= blowing mass flow
n	= load factor
p	= exponent in equation for flap blowing momentum coefficient
q	= free-stream dynamic pressure
S	= wing area
S_{af}	= wing area affected by blown flap
T_B	= blowing source thrust equivalent
t	= wing thickness
V_j	= blowing gas exit velocity, assuming isentropic flow conditions
W	= gross weight
W_B	= blowing power source weight
W_D	= blowing duct system weight
W_E	= engine weight
W_{E+C}	= equipment and crew weight
W_F	= fuel weight
W_{FS}	= fuel system weight
W_P	= payload weight
W_{S-W}	= aircraft structural weight excluding wing
W_W	= wing weight
ρ_F	= fuel density
Λ	= wing sweep
λ	= taper ratio

Subscripts

1	= aircraft without blown flap
2	= aircraft with blown flap
$A-W$	= aircraft minus wing

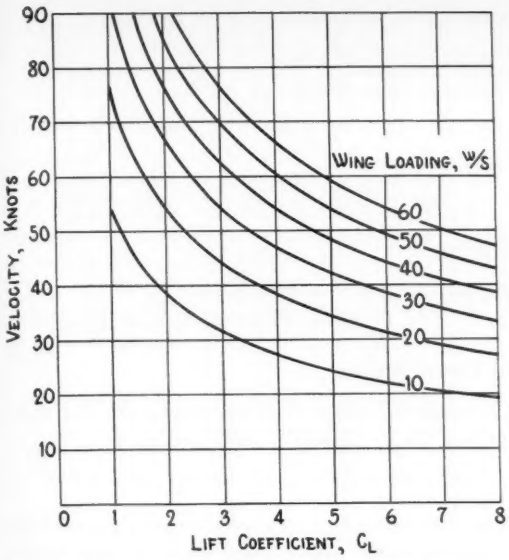

FIG. 1. Velocity as a function of wing loading and lift coefficient at sea level.

A maximum effort to achieve practical STOL performance is currently concentrated on transport aircraft. This paper is primarily concerned with determining the weight gains or penalties which are incurred by using a blown flap system.

ANALYSIS

Take-off and landing distances can be related almost directly to aircraft stall speed. STOL performance requires low stall speed. An aircraft's stall speed, in turn, is dependent on the aircraft's wing loading and maximum lift coefficient as shown in Fig. 1. The possibility of significantly decreasing the stall speed by increasing the lift coefficient is obvious. The blown flap is of interest primarily because of the possibilities it offers for obtaining high lift coefficients. On the other hand, low stall speeds can also be realized by means of low wing loadings. Since each of these two approaches to STOL performance has its drawbacks, as well as its advantages, it will be illuminating to compare them. For this purpose, each technique will be applied to the same, somewhat simplified—yet reasonable—configuration and the results examined.

The configuration considered here is typical for a transport-type aircraft intended to achieve high maximum lift. It has the following characteristics:

Aspect ratio = 10
Sweep = 0°
Taper ratio = 1.0
Wing section is a constant NACA 23018 airfoil.
Full-span, 25 per cent chord trailing-edge flaps

If high-velocity air or gas is blown over plain flaps on this configuration, the lifts shown in Fig. 2 can be anticipated. Fig. 2 is based largely on experimental data obtained with a closely similar planform. If the same configuration is equipped with unblown double-slotted flaps rather than blown flaps, a maximum lift coefficient of approximately 3.13 is attainable. It is apparent from Fig. 2 that, with sufficient blowing capacity, the lift capabilities of the blown flap considerably exceed those of an unblown flap.

An increase in lift (such as shown in Fig. 2 for the blown flap) can affect an aircraft design in several different ways:

(1) For a given wing loading, the stall speed can be decreased. However, the power and ducting installation required to provide and distribute the blowing air will displace weight and volume which might otherwise be available for payload or fuel. The aircraft's payload or range will consequently be decreased.

(2) For a given stall speed, the wing loading can be increased in either of two ways:

(a) The aircraft gross weight can be increased while the wing area remains unchanged. This should permit the aircraft to carry an increased fuel load, as well as the additional weight of the blowing system, so that its range will be increased. There is, of course, the problem of providing sufficient space for this purpose.

(b) The wing area can be reduced without changing the aircraft's gross weight. This entails a complete redistribution of the aircraft weight. The wing weight will be reduced, but the fuel requirements to maintain the same range capability will be increased.

If we concentrate our study on the last alternative, it should be possible to decide whether the wing weight reduction permitted by the use of a blown flap is greater or less than the weight increase due to the blowing installation and the additional fuel requirements. In essence, then, this study will compare the weight of the example aircraft, designed to achieve a given range and stall speed with a blown flap, to its weight with an unblown double-slotted flap and a larger wing providing the same performance.

A percentage weight breakdown for the example configuration with an unblown double-slotted flap might be as follows:

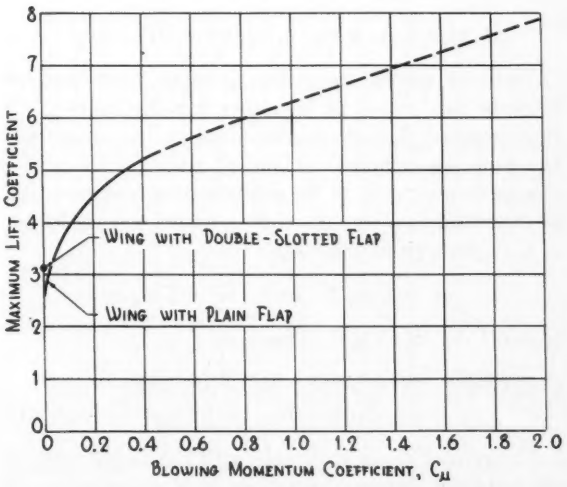

FIG. 2. Increase in maximum lift coefficient with flap blowing on an aspect ratio 10 wing with a full-span 25 per cent chord plain flap deflected 55°.

$$1 = W_P/W + W_{E+C}/W + W_{S-W}/W + W_W/W + W_E/W + W_F/W + W_{FS}/W \quad (1)$$

where $W_P/W = 0.14$, $W_{E+C}/W = 0.08$, $W_{S-W}/W = 0.17$, $W_W/W = 0.15$, $W_E/W = 0.16$, $W_F/W = 0.28$, $W_{FS}/W = 0.02$

For the same design with a blown plain flap, the terms W_W/W, W_F/W, and W_{FS}/W would be changed and the additional terms W_B/W and W_D/W must be considered. Let us then examine each of these five terms in turn.

Wing Weight

The wing weight can be estimated by means of Kelly's formula using empirical constants determined from studies at The Martin Company as typical for the transport class of aircraft.

$$W_W = 0.00333 \times \{(nA/\cos\Lambda) \times [(1+\lambda)/(2+\lambda)]\,[(W/S)/(t/c)]S^2\}^{0.63}$$

For a given load factor, wing planform, and wing thickness, the wing weight can be expressed as $W_W = K'\,[(W/S)S^2]^{0.63}$.

At a given stall speed and for the same value of K', comparing the blown and the unblown flap systems, the relative wing weights will be

$$(W_W/W)_2/(W_W/W)_1 = (S_2/S_1)^{1.26}\,[(W/S)_2/(W/S)_1]^{0.63}$$

or simply, for a given gross weight,

$$(W_W/W)_2/(W_W/W)_1 = (S_2/S_1)^{0.63} \quad (2)$$

Fuel Weight

The aircraft range can be approximated by Breguet's equation as

$$\text{Range} \sim (L/D)_{max} \ln\{1/[(1-W_F)/W]\}$$

or, since $(L/D)_{max} = (1/2)\sqrt{\pi Ae/C_{D_0}}$,

$$\text{Range} \sim 1/\sqrt{C_{D_0}} \ln\{1/[(1-W_F)/W]\}$$

To meet specific range requirements, this product must be held constant for either flap installation. If it is assumed that the entire configuration other than the wing size remains unchanged, then the effect of a change in wing area on the airplane drag coefficient can be described as $(D/q)_{A-W} = K$, $(D/q)_{W_1} = C_1$, $(D/q)_{W_2} = C_2$: for a given planform

$$C_1 = C_{D_{0_W}} S_1 \quad \text{and} \quad C_2 = C_{D_{0_W}} S_2$$

so that $C_2 = (S_2/S_1)C_1$. Therefore

$$C_{D_{01}}/C_{D_{02}} = [(K+C_1)/S_1]/[(K+C_2)/S_2] = S_2/S_1\,\{(K+C_1)/[K+C_1\,(S_2/S_1)]\}$$

The greater range realizable with the larger wing of the unblown flap configuration as a consequence of that airplane's smaller drag coefficient must be compensated for by an increase in fuel capacity for the configuration with blown flap in the ratio:

$$\frac{\ln\{1/[1-(W_F/W)_2]\}}{\ln\{1/[1-(W_F/W)_1]\}} = \left((S_1/S_2)\,\{[K+C_1\,(S_2/S_1)]/(K+C_1)\}\right)^{1/2}$$

or since

$$W_F/W \approx \text{const.}\,(\ln\{1/[1-(W_F/W)]\})^{0.84}$$

therefore

$$(W_F/W)_2/(W_F/W)_1 = \left((S_1/S_2) \times \{[K+C_1\,(S_2/S_1)]/(K+C_1)\}\right)^{0.42} \quad (3)$$

Fuel System Weight

An empirical relation for expressing the fuel system weight is $W_{FS} = 2.6\,(W_F/\rho_F)^{0.75}$ so that

$$W_{FS}/W = [2.6/(\rho_F{}^{0.75}\,W^{0.25})]\,(W_F/W)^{0.75}$$

The relative fuel system weight ratios for two different fuel capacities with a given airplane gross weight is

$$(W_{FS}/W)_2/(W_{FS}/W)_1 = [(W_F/W)_2/(W_F/W)_1]^{0.75}$$

and, utilizing Eq. (3) for the two wing areas,

$$(W_{FS}/W)_2/(W_{FS}/W)_1 = \left((S_1/S_2) \times \{[K+C_1\,(S_2/S_1)]/(K+C_1)\}\right)^{0.315} \quad (4)$$

Blowing Air Source Weight

The thrust equivalent of the blowing system requirements, disregarding losses, is $T_B = C_\mu\, qS_{af}$. This can be related to the airplane gross weight:

$$T_B/W = C_\mu\,(qS/W)\,(S_{af}/S) = (C_\mu/C_L)\,(S_{af}/S)$$

and the weight of the source of blowing air is then

$$W_B/W = (W_B/T_B)\,(C_\mu/C_L)\,(S_{af}/S) \quad (5)$$

Blowing Duct and Installation Weight

The blowing duct and installation weight are dependent upon many factors. For a given airflow, this weight will be a function of the pressure, temperature, and velocity of the blowing air in the duct, as well as the exit velocity at the flap. The duct may or may not be tapered spanwise, depending on the method used for distributing the blowing air. High-temperature blowing will require insulation and possibly a firewall. With all of the possible variables to consider, it is not expedient to derive a generalized relationship for the duct or installation weights. For simplicity, it will be assumed, on the basis of past experience, that $W_D/W \approx 0.01$ for a blown flap installation with appreciable blowing capacity. The weight-saving achieved for a plain flap vs. a double-slotted flap has been taken into account in this estimate.

In order to facilitate comparison between the double-slotted flap configuration and the blown flap configuration for a specified gross weight and stall speed, the following substitution can be made: $C_{L_1}/C_{L_2} = S_2/S_1$.

Eqs. (2), (3), and (4) can then be rewritten as

$$(W_W/W)_2/(W_W/W)_1 = (C_{L_1}/C_{L_2})^{0.63} \quad (6)$$

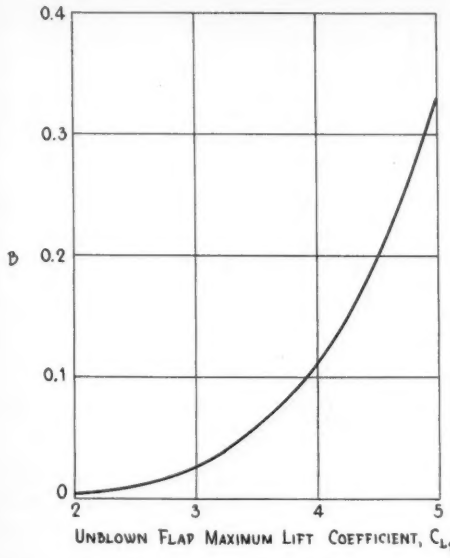

Fig. 3. Variation with unblown flap lift coefficient of the factor B in the relation $C_\mu = B(C_{L_1}/C_{L_2})^p$ for the conditions shown in Fig. 2.

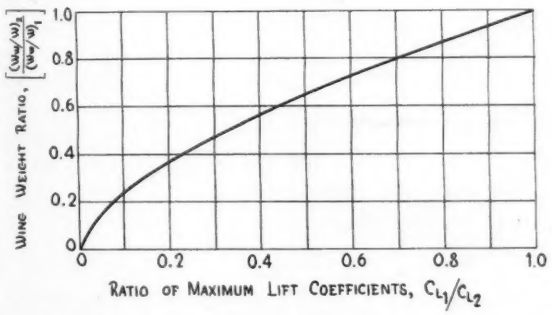

Fig. 4. Relative wing weight ratios as effected by the maximum lift coefficients.

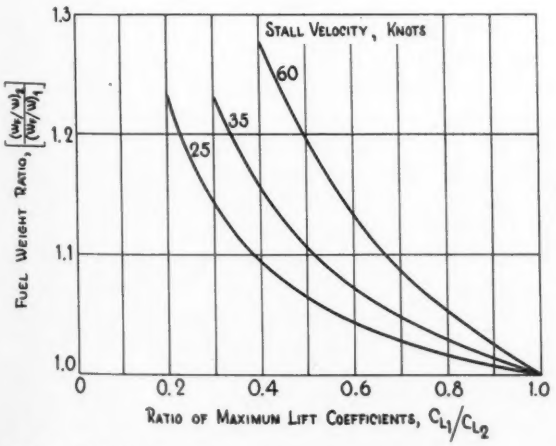

Fig. 5. Relative fuel weight ratios as effected by the maximum lift coefficients for several stall speeds.

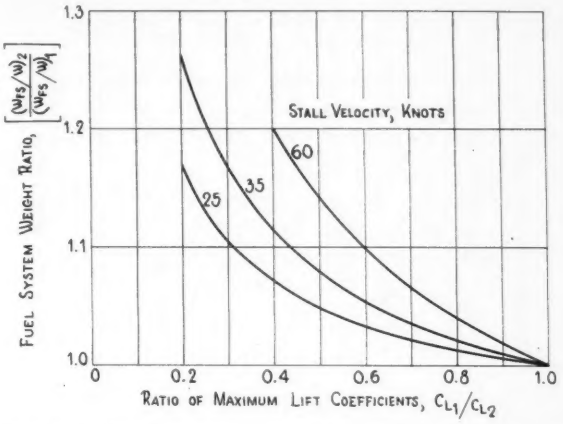

Fig. 6. Relative fuel system weight ratios as effected by the maximum lift coefficients for several stall speeds.

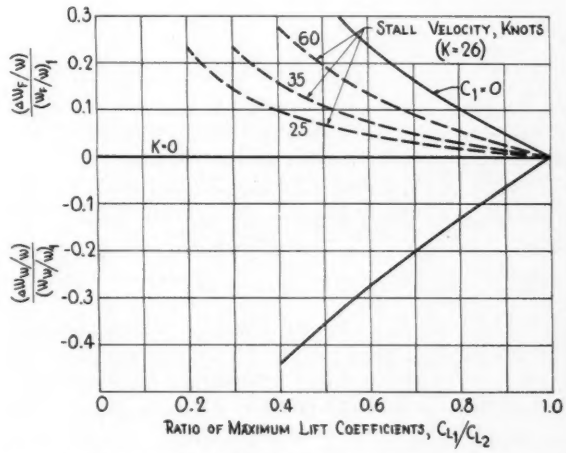

Fig. 7. Wing and fuel weight ratio increments due to differences in maximum lift coefficient.

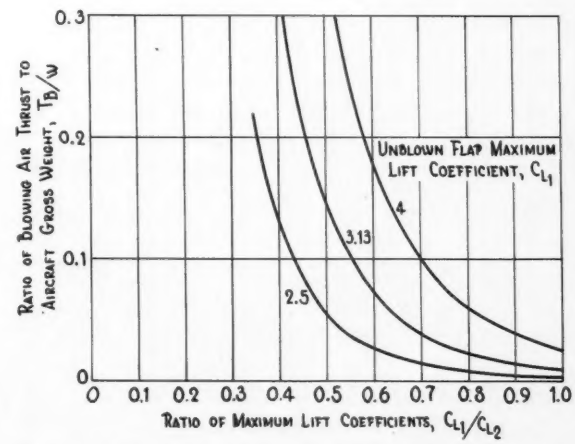

Fig. 8. Blown flap thrust requirements for specific increases in maximum lift coefficient.

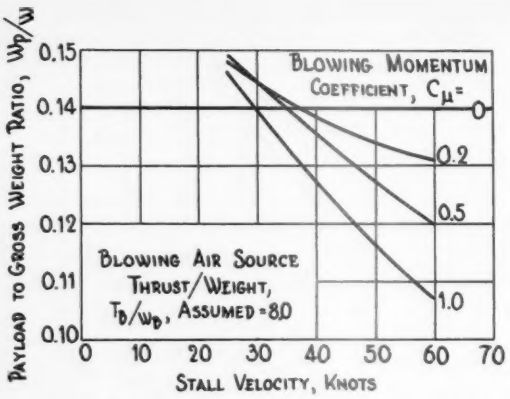

FIG. 9. Effect of blown flap on aircraft payload capacity for a range of possible design stall speeds.

$$(W_F/W)_2/(W_F/W)_1 = \left((C_{L_2}/C_{L_1})\left\{[K + C_1(C_{L_1}/C_{L_2})]/(K + C_1)\right\}\right)^{0.42} \quad (7)$$

$$(W_{FS}/W)_2/(W_{FS}/W)_1 = \left((C_{L_2}/C_{L_1}) \times \left\{[K + C_1\,(C_{L_1}/C_{L_2})]/(K + C_1)\right\}\right)^{0.315} \quad (8)$$

Examination of Fig. 2 reveals that an approximation of the form $C_\mu = B\ (C_{L_1}/C_{L_2})^p$ can be made for the greater portion of the indicated blowing range for the chosen configuration. It is also found that $p \approx -4.9$ for values of C_{L_1} between 2.5 and 5.0 and that B varies with C_{L_1} as shown in Fig. 3. Eq. (5) can then be written as

$$W_B/W = (W_B/T_B)\ (B/C_{L_1})\ (C_{L_1}/C_{L_2})^{p+1}\ (S_{af}/S_2) \quad (9)$$

Eqs. (6) through (9) can now be evaluated for any desired ratio of double-slotted flap configuration lift coefficient to blown flap configuration lift coefficient. The relative wing weights for the chosen airplane are as shown in Fig. 4. For this airplane, we can also specify the following further characteristics: W = 80,000 lbs., $C_{D_{0_W}} = 0.0112$, $C_{L_1} = 3.13$, and $K = 26$. The relative fuel weights under these assumed conditions are shown for several stall speeds in Fig. 5. Similarly, Fig. 6 shows the relative fuel system weights.

Figs. 4 and 5 are replotted in Fig. 7 as wing weight and fuel weight increments due to flap blowing. The upper curve in Fig. 7 represents the maximum possible fuel weight increment for the chosen configuration in accordance with Eq. (7). The curves shown for several stall speeds were all derived using the same body configuration ($K = 26$). The wing area, for the unblown flap configuration, was assumed to be that required to achieve the specified stall speed with the assumed weight and maximum lift coefficient.

TABLE 1

	35-Knot Stall Speed		60-Knot Stall Speed	
	Double-Slotted Flap	Blown Plain Flap	Double-Slotted Flap	Blown Plain Flap
Gross weight, lbs.	80,000	80,000	80,000	80,000
Blowing coefficient, C_μ	0	0.5	0	0.5
Wing area, sq.ft.	6,150	3,560	2,090	1,210
Wing loading, W/S	13	22.5	38.2	66
Cruise speed, V_{CR}	Blown flap V_{CR} = 1.26 (double-slotted flap V_{CR})		Blown flap V_{CR} = 1.21 (double-slotted flap V_{CR})	

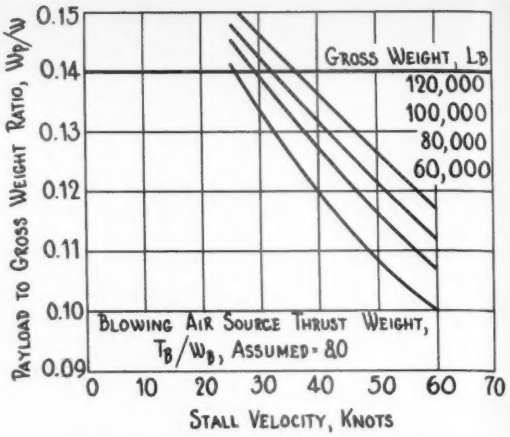

FIG. 10. Payload capacity for various blown flap aircraft gross weights over a range of possible design stall speeds; $C_\mu = 1.0$.

The blowing system thrust requirements for the example configuration are shown in Fig. 8. Several possible values of unblown flap configuration maximum lift coefficient have been included for comparison. Obviously, the more efficient the unblown flap system proves to be, the more thrust will be required for the blown flap system to exceed the unblown flap's performance. The weight contribution of the blowing system thrust source will depend upon the thrust to weight ratio of the system, as well as the thrust requirements.

Discussion

The preceding analysis has been used to examine the effect of a blown flap installation on the distribution of weight in the example aircraft. The results are summarized in Fig. 9 in terms of the aircraft's payload capacity. The analysis is only sufficiently refined to justify qualitative deductions. However, the indications are that, if the aircraft's stall speed is to be quite low (<40 knots), the blown flap configuration will probably have a larger payload capacity than an aircraft having the same stall speed and range capabilities but a larger wing and an unblown double-slotted flap. The opposite will be true for aircraft with stall speeds greater than 40 knots.

The weight picture will become more favorable for the blown flap aircraft if the required duct and installation weight can be minimized and the thrust to weight ratio of the blowing source increased. Examination of the relations used in the present analysis also indicates further improvement in the overall weight picture for the blown flap installation for aircraft of larger gross weight (Fig. 10) or shorter range requirements. For transport aircraft, this is commensurate with short-haul requirements for large payloads.

(*Continued on page 63*)

Some functional aspects and limitations of the instrumentation of a combined optical-inertial system for navigation in nearby interplanetary space are presented. The interplanetary space considered here is limited to those regions in the solar system where the visibility of the illuminated discs of nearby planets is acceptable for optical tracking purposes.

Interplanetary Navigation by

Optical Resection and Inertial Systems

Joel Carroll

American Bosch Arma Corporation

In order to navigate a vehicle from one point in space to another, it is fundamentally necessary to maintain in the instrumentation the relative position of the destination with respect to the vehicle. This relationship may be established in two ways, either by relating one point to the other directly as is done with homing devices, or by relating each of the points to a common reference and thus indirectly to each other as is done by means of compass and inertial techniques.

The homing method, when applicable, is more desirable than the common reference method since an external closed loop between destination and vehicle is necessarily available and all the instrumentation advantages of closed-loop techniques are applicable. This method, however, may be used only when the vehicle to be navigated can maintain optical or other contact with the terminus of the flight. This is not always possible in the general problem of space navigation.

The method requiring a common reference for relating the positions of the vehicle and the destination is more generally applicable to space navigation problems but lacks the closed-loop advantages. However, for many future as well as present applications, it is necessary to resort to this method, as, for example, in the navigation of an ICBM or a satellite vehicle.

The combined optical inertial system to be discussed may be used to generate the information necessary for navigation between any two points in the nearby space, be they physical bodies or arbitrary space points.

Various physical phenomena may be utilized to establish a space reference including the positions and velocities of the celestial bodies, which are relatively well known, and the linear and angular inertial characteristics of matter.

The positions of nearby celestial bodies provide a stable reference frame for determining the position, velocity, and attitude of the vehicle, as well as for the orientation of the components of the navigation and guidance system. Angles measured continuously at the vehicle between two pairs of celestial bodies are sufficient for determining vehicle velocity but with relatively poor precision and for determining vehicle position with relatively high precision. The method is called navigation by resection. At least three nearby celestial objects are required for this method, and they may be chosen from among the planets and the sun.

However, optical resection and inertial systems may be used to complement each other. The resection elements may be used to reorient the drifting inertial components continuously and to determine position continuously, while the inertial components may be used to measure the computed velocity increments for guidance or steering.

The Optical Resection System

Let us examine the resection problem from a geometric point of view (Fig. 1). Consider first the planar problem in which three known points A, B, and C are observed from point V where the angles α and β are measured. These measurements together with the known positions of the observed points determine the position of point V. This is the familiar "three-point method" used extensively in precise surveying and photogrammetric operations. The method has limitations, however, which depend, first, on the position of point V with respect to the circle which circumscribes the three known points and, second, on the proximity of point V to the triangle of known points. If point V lies on the circumscribing circle, then the position of V is indeterminate. If point V is very far removed from the triangle, or in other words, if the

This paper is a revised, updated, and declassified version of the author's presentation before the Astronautics Session, IAS National Midwestern Meeting on Guided Missiles, St. Louis, Mo., May 12–14, 1958.

The author is Senior Engineer, Arma Division.

angles α and β are both very small, then the precision of the position determination is extremely poor. On the other hand, when point V lies inside the triangle of fixed points, the position determination is strong.

If it is assumed that the angles α and β are measured with unit precision, say ± 1 in., the uncertainty in the computed position of point V for any configuration of triangle and point may be determined.[1] If we take a realistic configuration of points—for example, the positions of the planets at the arbitrarily chosen epoch January 1.0, 1948, as shown in Fig. 2—and if we consider the combination of planets including the earth, Venus, and Saturn as the three known points and the point V as the vehicle, then the maximum uncertainty in the position of point V is 800 miles per sec. error in both of the measured angles. If we consider another combination, that of the earth, Saturn, and the sun, the maximum uncertainty in vehicle position is 600 miles per sec. error in the measured angles.

Note that, in both of these examples, it was assumed that the resection problem was a planar problem, which in fact it is not. Nevertheless, these examples may be taken to give an estimate of the position accuracies attainable with a resection-type system. Note also that velocity determination by this system is very poor. The velocity of the vehicle could theoretically be determined from the rates at which the measured angles change. For the distances involved in interplanetary navigation and for reasonable vehicle velocities, these rates of change would be so small as to be completely swamped out by noise in the angle measuring system. Hence velocity information for steering purposes would have to be determined by other means. One such other means is the inertial guidance system.

The Inertial Guidance System

It will be assumed that the inertial measuring system for navigation and guidance contains an inertial measuring unit composed of three perfect, mutually orthogonal accelerometers which remain nonrotating with respect to inertial space during the vehicle flight as shown in Fig. 3.

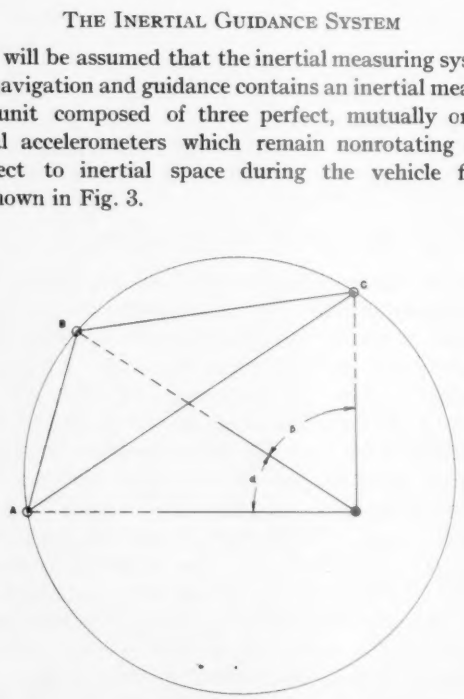

Fig. 1.

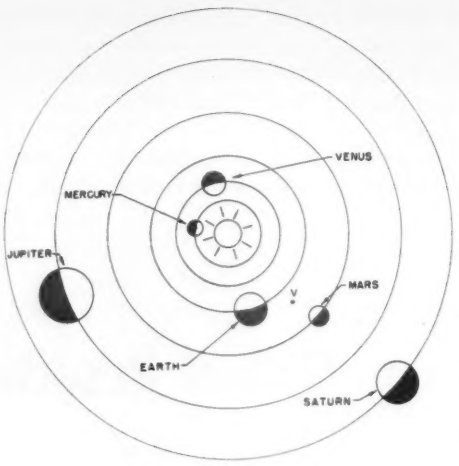

Fig. 2.

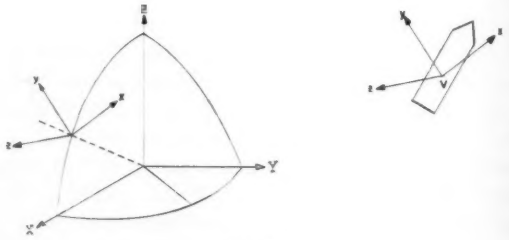

Fig. 3.

The coordinate system is defined by the directions of the sensitive axes of the accelerometers. The accelerometers measure the accelerations resulting from the applied thrust but not the accelerations from gravitational attraction. Hence the gravitational accelerations must be computed from the inferred position of the vehicle relative to the celestial bodies. Fig. 4 shows a block diagram of the navigation scheme for the inertial guidance system. The outputs of the accelerometers which measure the thrust accelerations are integrated to yield the components of thrust velocity. The gravity components for the different celestial bodies are computed in the gravity computer, are integrated, and are added to the thrust velocity components to yield the inertial components of velocity.

Errors in velocity and position result from accelerometer measurement errors, from coordinate system misorientation and drift, and from uncertainties in the gravitational constants associated with the planets. The gravitational uncertainties range from very small fractions of 1 per cent for the sun, earth, and Jupiter to 1 per cent for Venus and 20 per cent for Mercury. The perturbations in the vehicle flight path resulting from these uncertainties depend critically on the proximity of the flight path to the planets. Moreover, even if these perturbations could be measured, the inertial coordinate system maintained by the gyros would drift in the tens or hundreds of days required for interplanetary flights so that the applied corrections would be in considerable error.

The Combined Resection-Inertial System

A combined resection-inertial system provides a means for partially overcoming both difficulties. The resection components (Fig. 5) may be used to measure the resection angles for continuously determining position—and hence the perturbation effects—and also to provide continuously the space references for correcting the orientation of the inertial components. The inertial system may then be used to measure the applied increments in the magnitude and direction of the thrust velocity which are required to correct for the perturbation effects.

The initial ascent from the launch site to the desired orbit about the sun may be accomplished by a series of powered and coasting phases with the vehicle describing first a series of planetocentric orbits and finally the desired heliocentric orbit. In the time required for the initial ascent, the position and velocity of the vehicle may be determined by the optically monitored inertial system with much higher precision than that obtained by the resection system. It will be recalled that the resection system yields position errors of a few hundred miles per second error in the measured angles. For every hour of optically monitored inertial operation, the position error will be small. Except for the small corrections in velocity to be applied periodically with small increments of impulse, the major portion of the thrust velocity will be accumulated during the early part of the flight. During this interval of time, the vehicle is subject primarily to the gravitational fields of the earth and the sun, both of which are known to relatively high orders of precision. The position and velocity at the initial point of the desired orbit, as determined by the inertial system, provides a precise base point from which the desired changes in orbit parameters may be computed.

The computer in the system will be required to perform various functions, such as:

(1) Store the solar and planetary data needed for navigation.

(2) Compute and issue the engine ignition and cutoff signals.

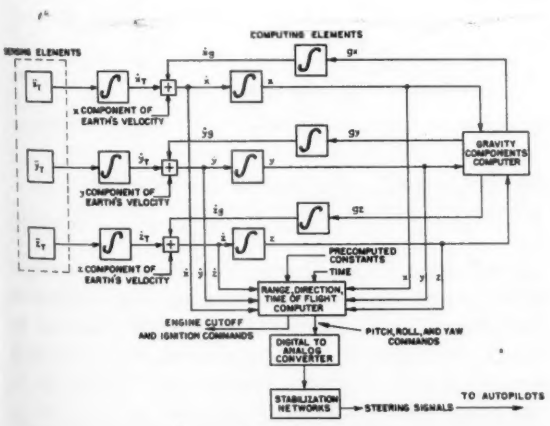

Fig. 4.

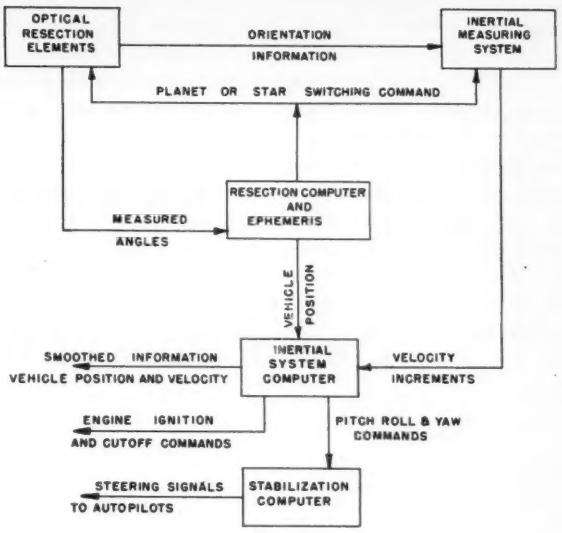

Fig. 5.

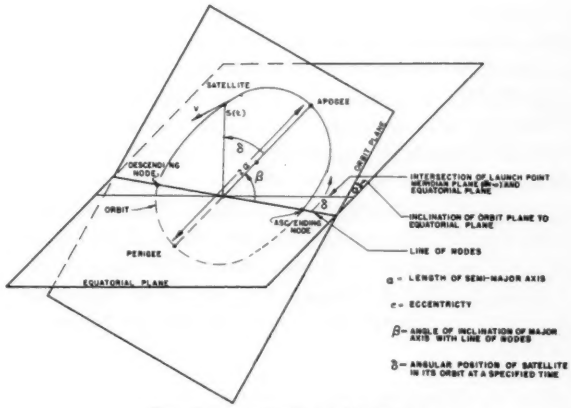
SATELLITE
APOGEE
DESCENDING NODE
ORBIT
ASC./ASCENDING NODE
PERIGEE
EQUATORIAL PLANE
ORBIT PLANE
INTERSECTION OF LAUNCH POINT MERIDIAN PLANE AND EQUATORIAL PLANE
INCLINATION OF ORBIT PLANE TO EQUATORIAL PLANE
LINE OF NODES
a = LENGTH OF SEMI-MAJOR AXIS
e = ECCENTRICITY
β = ANGLE OF INCLINATION OF MAJOR AXIS WITH LINE OF NODES
δ = ANGULAR POSITION OF SATELLITE IN ITS ORBIT AT A SPECIFIED TIME

Fig. 6. Osculating orbit plane.

(3) Compute and issue the steering signals in pitch, roll, and yaw.

(4) Switch the resection elements from one combination of sun and planets to another.

The complexity of the computation of the steering ignition and cutoff signals to be generated in the computer depends on the desired orbit of the space vehicle and thus, by implication, on the number of conditions to be satisfied at final thrust termination. These conditions may include any prescribed combination of the following six specified osculating orbit parameters (Fig. 6):

(1) The direction of the line of intersection of the orbit plane with the ecliptic (line of nodes).

(2) The angle of inclination of the orbit plane with the ecliptic (azimuth).

(3) The angle between the line of nodes and the major axis of the orbit.

(4) The length of the major axis.

(5) The eccentricity of the orbit.

(6) The time of vehicle arrival at the destination.

The simplest case, that of merely requiring the vehicle

(*Continued on page 75*)

Numerical solutions of the Taylor-Maccoll equations have been obtained for a variety of cone semivertex angles, ambient pressures, and flight velocities. A hypersonic similarity parameter permits correlation of these solutions with less than 1 per cent error.

Application of the Hypersonic Similarity Rule to Conical Flow of Dissociated Air

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IT HAS BEEN FELT for some time that the conical flow tables of Kopal[1] should be extended to include the effects of modified thermal properties at high flight velocities. This has recently been done by Feldman[2] who obtained an analytic solution of the modified equation, assuming an incompressible flow field. At the same time, more extensive numerical solutions of the Taylor-Maccoll equation were obtained at Convair.[3] This paper presents some of the results of these solutions. It is also shown that these results can be correlated through the use of a hypersonic similarity parameter, as first predicted by Dorrance[4] in 1951.

THE EQUATION AND SOLUTION

A complete analysis of the conical flow problem for dissociated air may be found in both references 2 and 3. A brief summary of the problem is given below.

The Taylor-Maccoll solution[5] for supersonic flow about cones is obtained from the conservation equations by assuming that the flow field is isentropic, irrotational, and conical. These conditions are met for high-temperature air if the air is in instantaneous equilibrium throughout the flow field between the shock and the body.

Under this assumption the Taylor-Maccoll equation is written

$$u'' = \{(u + u' \cot \theta)/[(u'/a)^2 - 1]\} - u; \qquad v = u' \quad (1)$$

where the primes denote differentiation with respect to θ, the angle between the cone axis and a ray through the cone vertex. Boundary conditions for Eq. (1) are: at the cone surface, $(\theta = \theta_c)$, $u' = v = 0$; at the shock wave, $(\theta = \theta_w)$, shock conditions satisfied. The variation of the speed of sound with velocity, necessary for the integration, is given by the energy equation

$$(V^2/2) + h = [(u^2 + u'^2)/2] + h = h_0 \quad (2)$$

and tabulated values of sound velocity as a function of enthalpy and entropy.[6] The entropy was obtained from normal shock solutions[7] along with values of the velocity components behind the shock, as functions of normal velocity ($V_1 \sin \theta_w$), pressure ($10^{-4} \leq p_1 \leq 10^{-1}$), and temperature ($T_1 = 491.7°\text{R.}$).

Integration of Eq. (1) was made on the Convair IBM

SYMBOLS

a	= Speed of sound	ft./sec.
a_R	= Speed of sound at 491.7°R. = 1089	ft./sec.
C_p	= Pressure coefficient = $2(p_s - p_1)/\rho_1 V_1^2$	
h	= Enthalpy	B.t.u./lb.
h_0	= Stagnation enthalpy	B.t.u./lb.
M	= Mach Number = V/a	
$\bar{M}$	= Reference Mach Number = V_1/a_R	
p	= Static pressure	atmospheres
R	= Gas constant for air	ft.^{2} sec.^{2} °R.
S/R	= Dimensionless entropy	
T	= Static temperature	degrees, Rankine
u	= Velocity parallel to ray through cone vertex	ft./sec.
v	= Velocity perpendicular to ray through cone vertex	ft./sec.
V	= $\sqrt{u^2 + v^2}$, total velocity	ft./sec.
γ	= Ratio of specific heats	
ρ	= Mass density	slugs/ft.^{3}
θ	= Angle between cone axis and ray through cone vertex	degrees
θ_c	= Angle between cone axis and cone surface	degrees
θ_w	= Angle between cone axis and conical shock wave	degrees

Subscripts

1 = Free stream
2 = Directly behind shock
R = Conditions at $T = 491.7°\text{R.}$
s = Streamline along cone surface

Miss Romig is Staff Scientist, Convair Scientific Research Laboratory, San Diego, Calif.

704. Various sets of solutions (cone angles) were obtained from fixed values of $V_1 \sin \theta_w$, p_1, and T_1 by proper variation of V_1 and θ_w. The cone angles for a set varied from 20° to 50°, in increments of 5°. It was necessary to iterate to obtain integral values of θ_v.

Presentation of the Solutions

Each set of solutions had in common, by virtue of the constancy of $V_1 \sin \theta_w$, p_1, and T_1, a single value of entropy, enthalpy, and normal velocity directly behind the shock. Since the isentropic compression in the flow field is very small for the high velocities studied, the enthalpy at the cone surface was also nearly constant (to one part in 10^4) for a given set of solutions. Thus the thermodynamic properties[8] p_s, T_s and ρ_s, functions of h_s and S/R, are also essentially constant for a set. Computation of a hypersonic similarity parameter, $V_1 \sin \theta_v$, indicated that this quantity varied by at most 1 per cent within a set. Thus one value of $V_1 \sin \theta_v$ can be used to represent the thermodynamic properties for a given set of cones with the same initial values of p_1, T_1, and $V_1 \sin \theta_w$.

For the purpose of plotting, it is convenient to express the flow parameters in dimensionless form. Although the solutions discussed here are strictly valid only for $T_1 = 491.7°\text{R}$, Hochstim[7] has shown that a ±50°R deviation from this value of T_1 incurs errors of less than ±10 per cent in the shock-wave parameters. Therefore, in order to allow freedom in the choice of T_1, the flow parameters are made dimensionless with respect to an arbitrary reference temperature $T_R = 491.7°\text{R}$. The dimensionless ratios for pressure, temperature, density, and Mach Number are then p_s/p_1, T_s/T_R, ρ_s/ρ_R, and $\tilde{M} \sin \theta_v = (V_1/a_R) \sin \theta_v$ respectively, where $a_R = 1089$ ft./sec.

These flow parameters are given in Figs. 1, 2, and 3 vs. $\tilde{M} \sin \theta_v$ for free-stream pressures $p_1 = 10^{-1}$, 10^{-2}, 10^{-3}, and 10^{-4}. The low speed results[1] are also shown here for comparison. Numerical values of the flow properties for free-stream temperatures other than T_R can be obtained simply by conversion of the true Mach Number, (V_1/a_1), to $\tilde{M}$.

The velocity at the cone surface will not correlate with $V_1 \sin \theta_v$. However, the energy conservation equation

$$(V_1^2/2) + h_1 = (u_s^2/2) + h_s \qquad (3)$$

rearranged to

$$V_1^2 - u_s^2 = 2(h_s - h_1) \qquad (4)$$

shows that the parameter $(V_1^2 - u_s^2)$ will correlate, since $(h_s - h_1)$ is almost constant for a given set of solutions.

This parameter, made dimensionless with respect to $V_1^2 \sin^2 \theta_v$, is given in Fig. 4. It is a rather useful parameter, since it is directly related to the surface enthalpy.

Other Solutions for the Conical Flow Problem

Two other solutions of the conical flow problem have been obtained for dissociated air. Both of these approximate solutions of Eq. (1) utilize the fact that the flow field is nearly incompressible for hypersonic velocities.

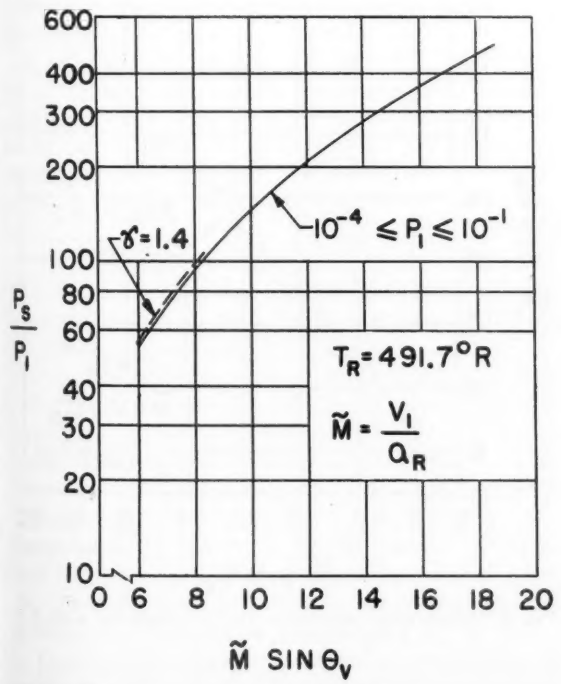

Fig. 1. Ratio of cone surface pressure to free-stream pressure for semivertex angles from 20°–50°.

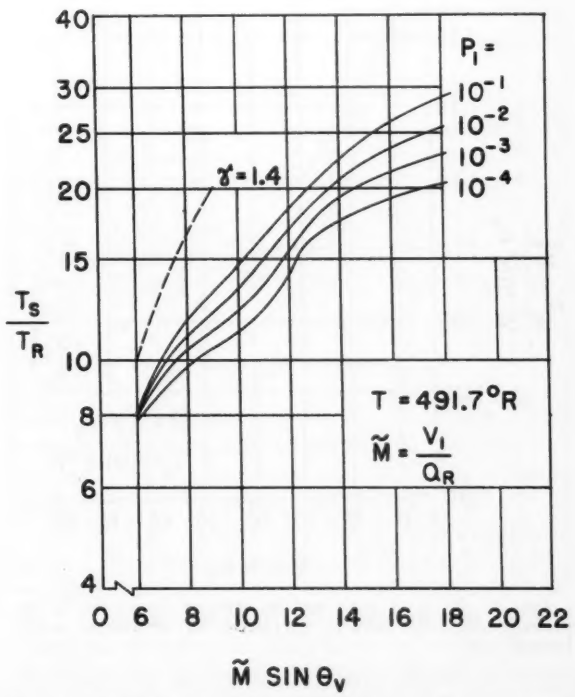

Fig. 2. Ratio of cone surface temperature to $T_R = 491.7°\text{R}$. for semivertex angles from 20°–50°.

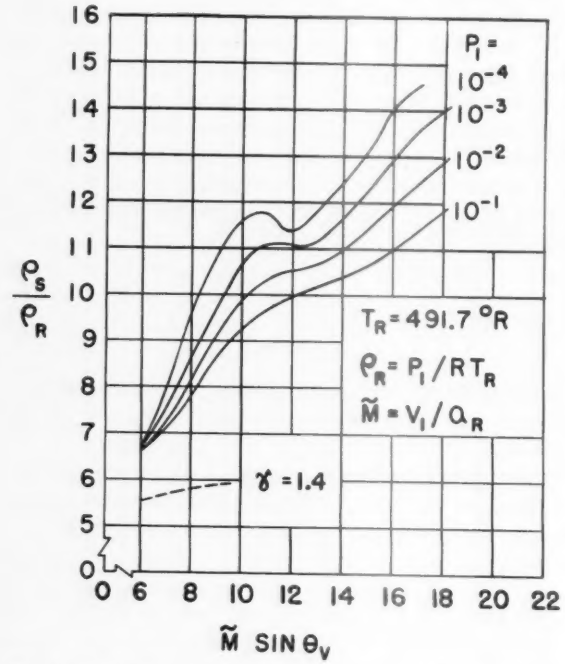

FIG. 3. Ratio of cone surface density to $\rho_R = p_1/RT_R$ for semivertex angles from 20°–50°.

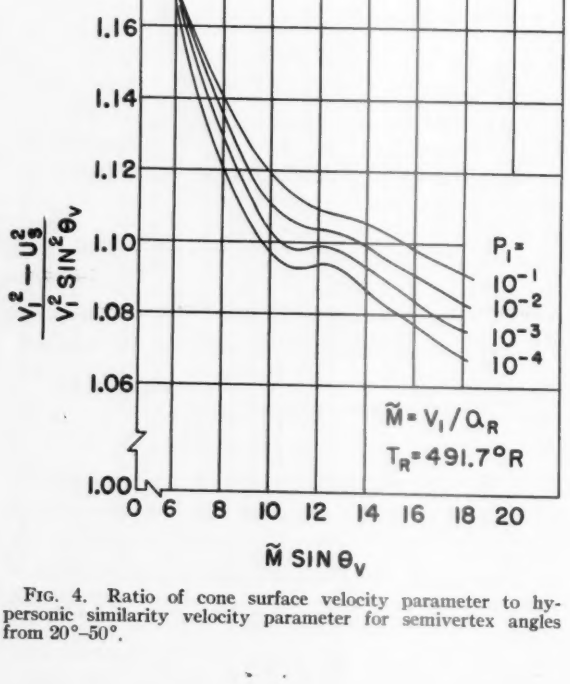

FIG. 4. Ratio of cone surface velocity parameter to hypersonic similarity velocity parameter for semivertex angles from 20°–50°.

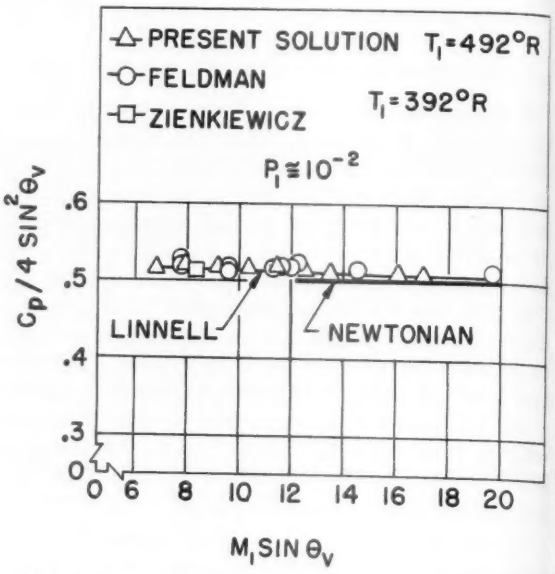

FIG. 5. Cone surface pressure coefficient at $p_1 \sim 10^{-2}$ atm.

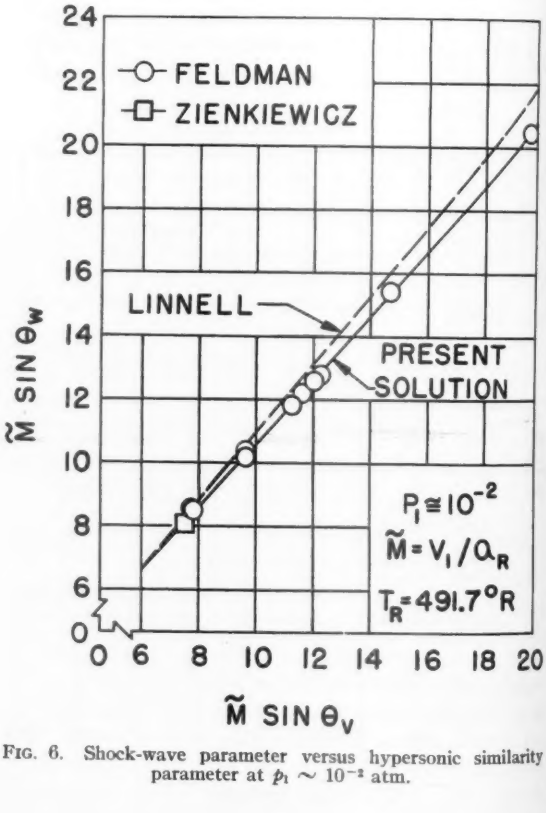

FIG. 6. Shock-wave parameter versus hypersonic similarity parameter at $p_1 \sim 10^{-2}$ atm.

The approximate solution of Feldman[2] is obtained by assuming, in Eq. (1), that the density is constant ($a \to \infty$). Then Eq. (1) reduces to

$$u'' + u' \cot \theta + 2u = 0 \qquad (5)$$

with the same boundary conditions as Eq. (1). This is integrable in closed form for surface velocity and cone angle. The conical flow parameters can be obtained from oblique shock solutions under the same flight conditions and shock-wave angle.

Feldman gives values for the pressure coefficient and shock-wave angle as functions of velocity and cone angle at an altitude of 100,000 ft. ($p_1 \sim 10^{-2}$, $T_1 = 392°$R.). These parameters are plotted in Figs. 5 and 6, along with corresponding values for the present solution. The pressure coefficient, by definition,

$$C_p/4 \sin^2 \theta_v = (p_s - p_1)/2\rho_1 V_1^2 \sin^2 \theta_v = [(p_s/p_1) - 1]/2\gamma_1 M_1^2 \sin^2 \theta_v \qquad (6)$$

is a function of the true free-stream Mach Number and pressure. Therefore, the values of $C_p/4 \sin^2 \theta_v$ in Fig. 5 for these two solutions are plotted vs. the free-stream Mach Number at which the solutions were obtained.

Fig. 5 indicates that these pressure coefficients do not correlate well with the similarity parameter. While p_s/p_1 = constant for a set of solutions, $V_1 \sin \theta_v$ varies by about 1 per cent, and Eq. (6) shows that $C_p/4 \sin^2 \theta_v$ will vary about 2 per cent for a set of solutions.

Furthermore, there are fluctuations present in the pressure coefficient curve, due to dissociation, (as in Fig. 3) which do not show on the pressure curve (Fig. 1) since the scale is so large. The "scatter" shown in Fig. 5 data is attributed to these facts. On the whole, the agreement between the approximate and exact numerical values of $C_p/4 \sin^2 \theta_v$ is very good, as Feldman has shown.[2]

For the complete solution—i.e., for all values of free-stream pressure—$C_p/4 \sin^2 \theta_v$ varies about 5 per cent for a given value of $V_1 \sin \theta_v$. This is due to variation in p_s/p_1 with p_1 which cannot be seen in Fig. 1 because of the magnitude of the scale.

The Newtonian value of pressure coefficient is

$$C_p/4 \sin^2 \theta_v = 0.5 \qquad (7)$$

This underestimates the true pressure coefficient by about 3–6 per cent at these flight conditions. This fact has previously been established by Feldman.[2]

The shock-wave angle is presented in Fig. 6. Here the solutions may be compared on the basis of identical free-stream velocities and pressures, since it was previously established that there is negligible effect of T_1 on the shock-wave parameters. For the convenience of plotting dimensionless quantities, the velocities are converted to $\tilde{M} = V_1/a_R$. The variation of $\tilde{M} \sin \theta_w$ with $\tilde{M} \sin \theta_v$ is almost linear. The points from Feldman's solution agree well with the curve of the present solution.

The single points due to Zienkiewicz[9] in Figs. 5 and 6 were calculated at 100,000 ft. altitude, using an approximate solution of Eq. (1), which assumes that the normal velocity, v, could be neglected. Eq. (1) reduces to

$$u'' + 2u = 0 \qquad (8)$$

Solution of Eq. (8) determines the velocity field and shock wave. The pressure was found by assuming that the composition of the air in the flow field is constant at the value just behind the shock. While the air composition used in his solution has since been revised, it is true that its effect on pressure is small (e.g., Fig. 1 or reference 7). The agreement with the other solutions is good, and it is felt that this approximate method would be even better at higher values of the similarity parameter.

Estimation Methods Based on Hypersonic Similarity

It is convenient, for design purposes, to have empirical equations which predict the conical flow parameters. Linnell and Bailey[10] have done this for the Kopal tables. Their equations give, for $M_1 > 6$, $\theta_v < 50°$,

$$M_1 \sin \theta_w = 1 - \cos \theta_v + \sqrt{1 + [(\gamma + 1)/2]M_1^2 \sin^2 \theta_v} \qquad (9)$$

$$C_p/4 \sin^2 \theta_v = (2.5 + 8M_1 \sin \theta_v)/(1 + 16M_1 \sin \theta_v) \qquad (10)$$

with an error of less than 5 per cent. These curves are presented in Figs. 5 and 6. The variation of $M_1 \sin \theta_w$ with cone angle in Eq. (9) cannot be represented in Fig. 6, due to the scale, so an average value of $\theta_v = 30°$ was used to indicate the relative position of Eq. (9) in comparison with the present solution.

It is felt that Eq. (10) represents the present solution adequately, considering the 5 per cent scatter in our values of $C_p/4 \sin^2 \theta_v$ over all free-stream pressure values.

An equation similar to Linnell's Eq. (9) can be obtained for the present results. Fig. 5 indicates that the variation of $\tilde{M} \sin \theta_w$ with $\tilde{M} \sin \theta_v$ is essentially linear. Therefore, an equation of the form

$$\tilde{M} \sin \theta_w = A(p_1) + B(p_1)\tilde{M} \sin \theta_v \qquad (11)$$

is appropriate, for $\tilde{M} \sin \theta_v > 6$. A and B are given by

$$\left.\begin{aligned} A(p_1) &= 0.39 - 0.01 \log p_1 \\ B(p_1) &= 1.03 + 0.005 \log p_1 \end{aligned}\right\} \qquad (12)$$

where p_1 is free-stream pressure in atmospheres. This equation represents the tabulated values within ±1 per cent. If less accuracy is needed, the pressure terms in Eq. (12) may be neglected.

Eqs. (10)–(12) are recommended for estimation of shock-wave angle and pressure coefficient at hypersonic velocities. It would be possible, although not practical, to determine empirical equations for the flow properties of Figs. 1–4. The changes in slope exhibited by density, temperature, and velocity would complicate the curve-fitting.

(*Continued on page 75*)

"Briefing as a method of communication has the advantages of getting the message across, immediate feedback, versatility, and capability of providing a permanent record."

The Engineering Briefing—A Communication Medium

William R. Dunbar
North American Aviation, Inc.

THIS ARTICLE has been motivated by a desire to put down for the record the thoughts the author has had and the inputs received during his participation in the recent competitions for the Air Force F-108 Interceptor and B-70 Strategic Bomber development programs. Acknowledgment is made of the fact that many of the techniques presented here reflect group activity and the ideas and experiences of others in the organization, as well as the author's personal observations.

Communication lines between individuals and groups, even within a rather close-knit organization, are frequently confused and tenuous. This has been especially evident in preliminary design work where new ideas and concepts continually cut across many of the traditional disciplines. Where ideas or problem areas are not clearly defined, it becomes difficult to distinguish between the processes of communication and evaluation. Many of us have started out with the goal of eliciting help from another group that is accustomed to thinking in terms of another viewpoint and have found that, by the time the problem is put into a form in which it can be communicated, it has taken on entirely different characteristics. In some cases, it may be found that the problem was originally formulated on the basis of an erroneous premise and is discarded in favor of an entirely different approach. Thus communication may appear almost as an end in itself, the design ideas following in its wake. The briefing process functions in much the same way. There is always major overlap between the development of presentation and the development of the ideas to be presented. Thus the briefing requirement has brought in its wake a discipline of its own which has provided the stimulus for a host of new ideas, many of which may not be brought out till the presentation reaches the firing line and the briefer receives feedback from those whom he proposes to inform.

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The briefing, in many areas, is replacing the technical report as a medium of communication and for good reason. The briefing implies a dynamic exchange of information and ideas. It is alive. The technical report is invaluable as a documentation method for detailed evaluation or analysis of a problem situation, but, let's face it, the catacombs are jammed with reports that will never see the light of day.

An example of use of the briefing within an engineering organization might be that of gaining management support for a research and development program or a design idea. Outside of the organization, the method may be used to coordinate the efforts of associate contractors or, in the competition for a contract, to sell the customer on the capabilities of the organization to get a job done. The term is used here, however, in relation to presentation at the technical or working level, such as a briefing which would be delivered to Air Force technical personnel, or to associate contractors with the purpose of obtaining coordinated effort on a weapon system development.

ADVANTAGES

The briefing may be described as an extension of the group conference in the direction of more emphasis on organization and the use of visual cues. In fact, the discussion is oriented around the visual cues instead of vice versa. As a presentation method, the briefing has the following advantages:

Getting the Message Across

The public speaker enters upon his audience's awareness primarily through its auditory channels while all the other senses are taking a holiday. The visual medium, however, can be used to advantage as an additional channel through which complementary stimuli can be introduced to augment the perception of an idea and create a more lasting impression.

Thus the visual cues (illustrative material on the briefing charts) not only aid in getting the ideas across,

but also clarify the logical sequence and build-up of arguments. In addition, the charts form a focal point for discussion before or after the briefing, bringing out "feedback" which might not otherwise be brought to light.

Speaker's Aid

Probably the most obvious advantage of the briefing chart is its value to the speaker as an outline of the ideas to be presented. At least as important, but not as obvious, is the use of the charts in the formulation period as a feedback stimulus to the briefer himself. The charts here become a medium through which ideas may be contributed to the presentation and context by others in the organization who have contact with the effort.

Permanent Record

The charts may be reduced to report size and combined with the speaker's pitch as supporting text which may be distributed as a brochure to the briefees as a documentation of the briefing. Further, if time is not available to incorporate the text, the charts themselves, when bound in brochure form, may provide a coherent summary of the discussion's high points. Also, formal engineering reports stand to benefit from the presentation thinking which has been invested in the charts and may incorporate existing or modified charts either in a summary or interspersed throughout the report in brochure style.

Versatility

The briefing charts may be reproduced in various sizes by photographic methods so that they are adaptable to different purposes and situations. For the "just-in-case" situation or the small informal group, a table-top size can be utilized with a ring binder type of easel which can be easily carried in a brief case. For the audience which is too large to make use of the large flip charts, $8^1/_2$ by 11 reproductions can be shown on a screen by utilizing an opaque projector.

The briefing type of presentation is flexible, mobile, and quick reacting. With the necessary technical information available, a well-equipped engineering organization can get a show on the road within a few days of the time the briefing requirement jells. Also, if reappraisal in the field indicates drastic changes in the briefing, charts may be readily eliminated, rearranged, or changed, and even new charts may be created with a sheet of paper and a grease pencil.

Organization

Organization of a briefing follows directly from the purpose of the briefing and the audience to whom it will be directed. Many types of outlines may be considered—such as problem area, sequence of development, or logical argument—but usually the best arrangement is found to be a combination of two or more general patterns.

Some lead-in should be made which will relate each subject to the audience's past experience. As an example, if the subject is the solution of a design problem, the following arrangement has been applied successfully:

(1) Current practice in the problem area.

(2) Why current practice is no longer an adequate solution to the problem.

(3) Proposed new solution with appropriate substantiation.

(4) Plan of action for further development.

Symbols

An ancient Chinese philosopher is quoted as saying, "One picture is worth a thousand words." As a test case, suppose we look at a couple of ideas such as "environment" or "performance." In trying to draw pictures to represent these two concepts, it becomes evident that the ancient philosopher might just as well have reversed his statement. If we were to postulate for ourselves, we might say, "To each idea, its appropriate symbols." However, this is no more than a statement of the everyday problem of our scientific culture as it probes deeper into the physical world and continually devises new symbol systems to describe and condense what it finds. The problem of communicating ideas to others in the briefing situation, however, requires the use only of those symbols which are within the ken of the audience and will cue them to the goal direction of the briefing. This may automatically limit the number and type of ideas which can be presented.

Several types of cues (symbols) are at the disposal of the briefer and may be grouped as follows:

(1) Cues provided by the speaker: auditory, visual (arm waving, etc.), and subliminal.

(2) The three-dimensional model or mockup.

(3) Visual cues provided by the charts: perspective pictorial, orthographic projection, schematic or diagrammatic, curves and numbers, equations, and the written word.

Only the last group will be discussed here since categories 1 and 2 are considered outside the scope of this article.

Development of the Visual Cues

The development of the briefing charts is the keynote of the preparation for the briefing, and here some general criteria may be kept in mind.

The material should be presented in a manner that is as simple and straightforward as possible in recognition of the capabilities of the audience to absorb the ideas. The briefer, already armed with months of work with problems to be presented, may require several days to prepare the briefing itself. He is himself so thoroughly familiar with the subject matter that he has a tendency to overestimate his audience's ability to absorb what he has to present.

Presentation problems cannot usually be resolved by a simple upgrading of cues but require a new viewpoint on the subject matter and the elimination of secondary material so that the main points can be properly symbolized for good reception. Figs. 1, 2, and 3 are used to illustrate what can be done by shifting the emphasis in the subject matter and changing the viewpoint on the use of symbols.

The subject to be presented is acoustic noise in a combat aircraft with the purpose of showing that the noise levels are acceptable. The first chart (Fig. 1) shows, for a specific flight condition, sound pressure levels within the cabin of the subject aircraft and within the helmets worn by the crew. Comparisons are made with familiar environments to give the audience a feel for the values shown. The material is described graphically here by plotting against frequency, which is important from the standpoint of speech interference. The realistic definition of speech interference, however, is quite complex so, rather than lead into this subject, it may be preferable to introduce only the overall sound pressure level, thereby sacrificing technical detail for clarity. This is done in the second chart (Fig. 2) which merely enumerates the values with a verbal title for each one.

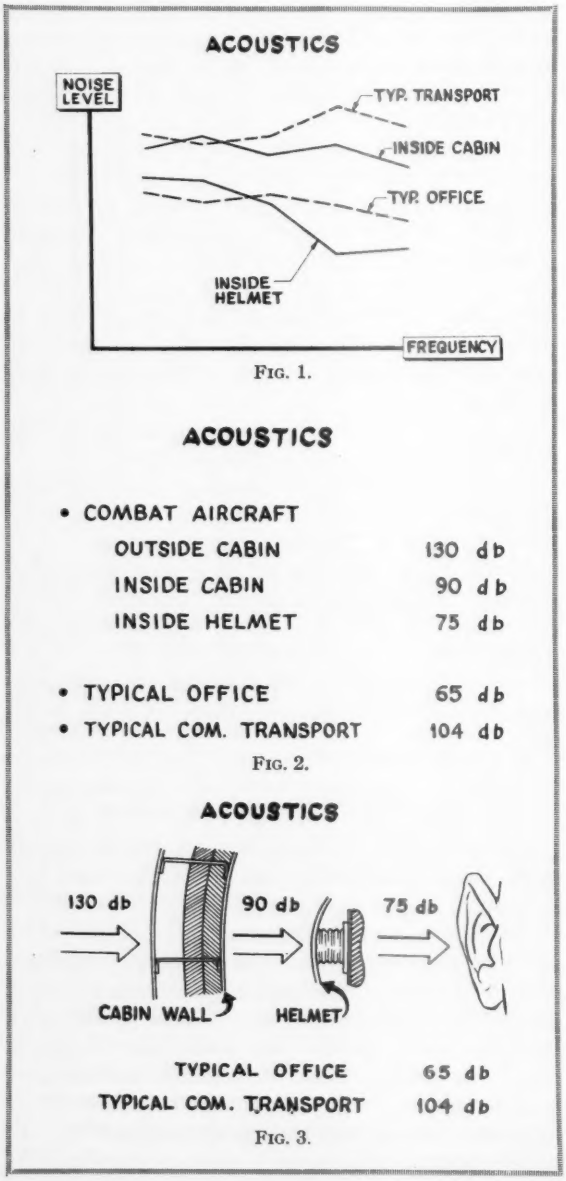

FIG. 1.

FIG. 2.

FIG. 3.

The last chart (Fig. 3) incorporates pictorial symbols to improve the reception. Note that the story goes from left to right and from top to bottom, taking advantage of the preconditioning from reading the printed page. Also the chart presents in a sense a complete story because it starts out with the environment problem, goes through the design solution of the problem to the final result, and then draws comparisons to tie the results in with the everyday experience of anyone in the audience.

The use of word or outline charts should be avoided wherever possible. Granted the outline chart provides a condensed speaker's aid in the form of precise and sequential notes, but the appropriate place for speaker's notes is not on the briefing chart. Granted also that it may be difficult to create a pictorial chart that will do the same job, still it should be borne in mind that the written words are in a sense the same type of symbol as the spoken words, and do not strongly reinforce the speaker's message, but may actually compete with the speaker for the listener's attention.

Word charts are often used where sequence and organization of ideas is the prime message. In this case, consideration should be given to a block diagram or flow chart, which may illustrate better the relationship among the various items. From here it may be possible to replace the unstimulating little blocks with some visual cues which will enhance the reception potential of the chart, and replace the lines with symbols such as arrows indicating the interaction among the various elements.

Words may be used to advantage, however, as backup cues wherever the illustrative symbol may be misunderstood. Words are normally used also on title charts, to introduce the briefing, or as subtitles within the briefing wherever the subject is changed, in order to reorient the audience and strengthen the continuity and organization of the presentation. Normally titles such as "environment," "reliability," etc., as we have seen before, are difficult to "mickey mouse" because of the breadth of coverage and conceptuality of their meaning.

Delivery of the Briefing

The briefer approaches his task with certain goals in mind:

(1) To give a picture of his organization's point of view in a manner which will be as clear, complete, and effective as possible.

(2) To make the organization which he represents look as good as possible through his own capabilities since he symbolizes the organization itself to the personnel with whom he comes in contact.

(3) To generate, receive, and interpret as much feedback as possible to be used in the formulation of future activity or for the detection of "brush fires."

With these responsibilities, he approaches the briefing prepared as best he can be for any situation which may arise. If he had his choice, he would pick his audience from only those who are intensely interested in his subject and are ready to participate freely in the discussion, but would not be likely to think of any questions he is not prepared to answer.

This, of course, is the ideal situation which cannot be constructed. Many briefers prefer a group of listeners who will generate feedback during the briefing in the form of questions or even discussion among themselves. This enables him to "play it by ear" and tailor his discussion to fit the needs of the situation as it progresses. However, if he learns to depend on this type of stimulus in the preparation of his pitch, misfortune may befall him on the days when he is confronted with an audience which has been previously instructed for proprietary or policy reasons not to tip their hand in any way. For "nul"-type circumstances of this sort, the briefer needs a carefully organized and polished presentation as if he were delivering a public address.

The best known method of preparing the presentation is to go through a number of dry runs prior to the time the show goes on the road. The dry runs should be made with an audience which has enough people in it who are both vocal and unfamiliar with the subject so that the organization and presentation of the material can be adequately wrung out. Preferably this should be done early in the formulation period of the briefing so that major changes can be made in the sequence and chart presentation without setbacks in the program.

In the delivery of the message, care must be taken to get the ideas across clearly and in a sequence which will be logical and understandable to the listeners. If charts are at all complex, the briefer should make every effort to be sure that the ideas conveyed by each chart are firmly received and ensconced before he continues with his supporting pitch. If he does not, the message may be lost in the confusion between visual and auditory cues competing for the receivers' attention.

When the time available for the presentation is short, speeding up the speaking rate is an ill-advised solution to the problem. The audience can ingest and retain only a given number of well-delivered ideas in a given time. The speaker who hurries through the presentation with one eye on his watch becomes more aware of his time limitations than his contact with the listeners. It is suggested that a more effective approach would be to eliminate some of the secondary material in order to carry the main points adequately.

Conclusion

In summary it may be said that:

(1) The processes of communication and design thinking cannot be isolated one from the other.

(2) Briefing as a method of communication has the advantages of getting the message across, immediate feedback, versatility, and capability of providing a permanent record.

(3) The visual cues selected should support the speaker's pitch with flash comprehension by the audience, not compete with the speaker for the audience's attention.

✦ ✦ ✦

Blown Flap System (Continued from page 52)

The weight comparison presented here is only one of many factors upon which a decision for or against a blown flap installation will hinge. There are, for example, practical limitations to the permissible size of a wing which detract from the advantages of a low wing loading. There are also the increased cruise and maximum speeds of the higher wing loading to be considered. Table 1 gives comparative data showing some of these differences for possible cases.

As shown in Table 1, for the lower stall speed, the blown flap offers the advantages of a considerably smaller wing and higher cruise speed at no expense in payload capacity (see Fig. 9). For the example aircraft with a 60-knot design stall speed, the advantages of the blown flap must be weighed against the indication in Fig. 9, for this case, that the aircraft with the blown flap will have 14 per cent less payload capacity for the same range.

It is apparent that for true STOL performance, which requires very low stall speeds, a comparison between low wing loading and high lift coefficient obtained by means of a blown flap must favor the blown flap from the standpoint of weight, as well as overall performance. If the take-off and landing distances are to be moderate rather than very short, requiring only moderately low stall speeds, a weight analysis may favor the low wing loading and require a more detailed comparison of all the other significant factors before a proper choice of design is feasible.

Static thrust becomes highly important when a propeller is to be used to provide it, and thus the lift for a vertical take-off type of aircraft. Present test data, however, are meager, and extensive experimental investigation is necessary.

Propeller Static Thrust

Ken S. Coward

Ryan Aeronautical Company

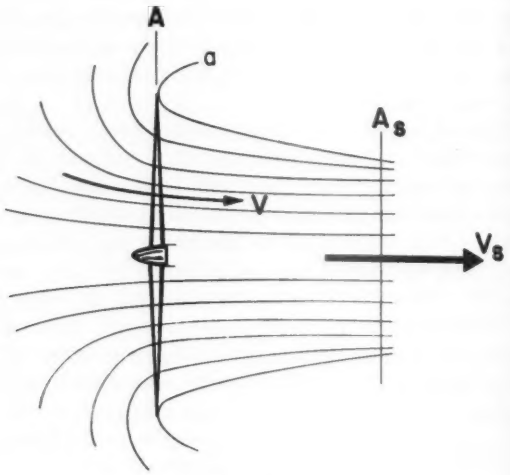

FIG. 1.

SINCE THE SUBJECT of propeller-driven VTOL aircraft started to receive considerable attention recently, some branches of the aircraft industry and some research agencies have been focusing much interest on the static thrust of propellers. Where a propeller is to be used as a means of providing the static thrust and thus the lift for a vertical take-off type of aircraft, the subject of static thrust becomes all important. Presented here is a brief treatment of the basic theory involved, a presentation of the available test data, and a general method for the rapid computation of static thrust using a static efficiency (or figure of merit) term. Reference 1 presents a general method for establishing the boundary conditions in which efficient operation can be obtained for both static and forward flight regimes.

THEORY

The development of static thrust by a propeller involves the acceleration of a mass of air (Fig. 1). The thrust equals the mass flow times the change in velocity, or $\rho VA\,V_s$, where the mass has been accelerated from zero velocity to a final slipstream velocity V_s. Thus

$$T = \rho VA\,V_s \qquad (1)$$

The power is the rate of change of kinetic energy, or $(1/2)\rho VA\,V_s^2$.

Thus $$P = (1/2)\rho VA\,V_s^2 \qquad (2)$$

SYMBOLS

A	=	Cross-sectional area, ft.^{2}
BHP	=	Brake horsepower
C_t	=	Thrust coefficient $= T/\rho n^2 D^4$
C_p	=	Power coefficient $= P/\rho n^3 D^5$
D	=	Diameter, ft.
F_d	=	Duct force, lbs.
$F.M.$	=	Figure of merit
M_{tip}	=	Propeller tip Mach Number
n	=	Propeller speed, r.p.s.
N	=	Propeller speed, r.p.m.
P	=	Ideal power, ft.-lbs./sec.
P_A	=	Actual power, ft.-lbs./sec.
T	=	Static thrust, lbs.
ρ	=	Mass density, slugs/ft.^{3}
ρ_0	=	Sea level standard mass density = 0.002378 slugs/ft.^{3}
σ	=	Density ratio $= \rho/\rho_0$

Subscripts

D	=	Ducted
U	=	Unducted
s	=	Slipstream
p	=	Propeller

Combining Eqs. (1) and (2), it is found that the power is a function of the thrust developed and the final slipstream velocity, thus

$$P = TV_s/2 \qquad (3)$$

Letting $V_s = (V_s/V)V$, from Eq. (1):

$$T = \rho\, VA(V_s/V)V = \rho\, A\, V^2(V_s/V) \qquad (4)$$

and from Eq. (2):

$$P = (1/2)\rho VA(V_s/V)^2V^2 = (1/2)\rho V^3(V_s/V)^2A \qquad (5)$$

Mr. Coward is Preliminary Design Engineer.

Solving Eq. (4) for V, and substituting in Eq. (5):

$$P = (1/2)\rho(V_s/V)^2 A[T/\rho A(V_s/V)]^{3/2} \quad (6)$$

Now, for incompressible flow: $V_s/V = A/A_s$, and substituting this in Eq. (6): and solving for T:

$$T = (2)^{2/3}\rho^{1/3}A^{1/3}P^{2/3}/(A/A_s)^{1/3} \quad (7)$$

The basic momentum theory for an unducted propeller yields $(A/A_s) = 2$, which when substituted in Eq. (7) yields

$$T = (2\rho A)^{1/3}P^{2/3} \quad (8)$$

Now, the term "figure of merit" is introduced, and taking for the definition of figure of merit the logical one as follows:

$$\overline{\text{F.M.}} = \left.\frac{\text{power input (ideal)}}{\text{power input (actual)}}\right\} \text{for a given static thrust}$$

This definition, which is the one used by the helicopter industry, is considered the only reasonable one since it relates the actual power required by a propeller to develop static thrust to the "ideal" power to develop that thrust. The ideal power is that power required to accelerate the air mass, assuming no energy loss in slipstream rotation, turbulence, etc.

Thus $$\overline{F.M.} = P/P_A \quad (9)$$

The following substitutions can now be made in Eq. (8):

$$\rho = (\rho/\rho_0)\rho_0 = \sigma\rho_0 = \sigma(0.002378)$$
$$A = \pi D^2/4$$
$$P = P_A\,\overline{F.M.} = (BHP)\,(550)\,\overline{F.M.}$$

The following final expression results:

$$T = 10.42\,[\overline{F.M.}\cdot D\cdot BHP\sigma^{1/2}]^{2/3} \quad (10)$$

This expression is very useful in the rapid determination of propeller static thrust when the diameter, horsepower, and ambient conditions are known. The figure of merit is obtained from test data. It is identical with the expressions shown by Kuhn in reference 2 and Zimmerman in reference 3.

Efforts are currently being made to determine propeller static thrust analytically, which is the same thing as attempting to determine the figure of merit analytically. This procedure requires repeated comparison of the analytical method with the test data, with sufficient elaboration of the theory to obtain good agreement. Examination of flow conditions with a physical propeller developing static thrust indicates that this process will be difficult.

In proceeding from Eq. (7) to Eq. (8), the relationship of $A/A_s = 2$ for an unducted propeller was used. When a duct is used with a propeller, this value no longer applies. Assuming that the duct exit does not diverge at such a rate that the flow no longer remains attached to the walls of the duct, the final slipstream velocity V_s is the velocity at the duct exit. Under such a condition, the term A/A_s can remain in the general expression, and the following equation is developed:

$$T = 13.13[\overline{F.M.}\cdot D\cdot BHP\,\sigma^{1/2}\,(A_s/A)^{1/2}]^{2/3} \quad (11)$$

Using Eq. (7) and Eq. (8), it can be shown that the ratio of the ideal thrust of a ducted to an unducted propeller for a given power and propeller diameter is simply 1.26 times the cube root of the area ratio:

$$T_d/T_u = (1.26)\,(A_s/A)^{1/3} \quad (12)$$

Examination of both Eq. (1) and Eq. (11) reveals that the development of static thrust for a given power depends as much on the diameter as on the power itself. The effect of a duct, then, is the same as simply increasing the diameter.

It can be shown that the total thrust of a ducted propeller is a combination of the propeller thrust and a force on the duct in the thrust direction. The following expression can be developed:

$$F_d = T\{1 - [0.5/(A_s/A)]\} \quad (13)$$

This expression indicates that the magnitude of the duct force is a function of the duct exit area to propeller disc area ratio. Thus, for a straight duct, one-half of the total thrust consists of the force acting on the duct. As the duct exit becomes more divergent, the greater becomes the duct force with respect to the total force.

Notice that the duct inlet radius does not enter the equations. It can be shown experimentally that if the duct inlet radius is made too small (less than about 6 per cent of the inlet diameter, according to recent unpublished NASA tests) the flow will separate from the walls inside the duct, and the effect of the duct will be lost. One may conclude from this that the inlet radius is not significant, provided it be kept higher than 6 per cent of the inlet diameter. The data of reference 5 shows this reduction in $\overline{F.M.}$ with inlet radii less than 6 per cent the diameter, but does not extend far enough to clearly indicate the effect of larger radii. Examination of Eq. (12) indicates that the greater the divergence of the exit, the greater will be the static thrust. There is a practical limiting divergent angle, however, above which the flow will separate from the walls. This angle is generally considered to be about 8°. The Forrestal Research Center has performed some smoke tunnel tests in which BLC was applied to the duct exit in an attempt to improve the divergent flow, permitting higher divergent angles.

The determination of figure of merit from test data to be used in Eq. (10) can be accomplished as follows: examining the available test data, it was found that the thrust and power characteristics are usually expressed in terms of the thrust and power coefficients C_t and C_p. The figure of merit can be expressed in terms of these coefficients by solving Eq. (8) for ideal power P:

$$P = T^{3/2}/(2\rho A)^{1/2} \quad (14)$$

The actual power, by definition, is $C_p\,\rho n^3\,D^5$. The thrust in Eq. (14) can be expressed as $C_t\,\rho n^2\,D^4$. Then

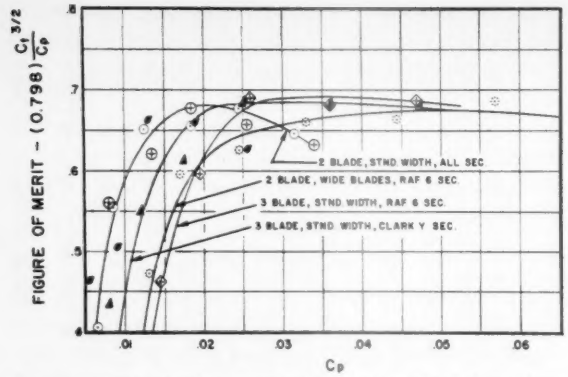
FIGURE OF MERIT - (0.798) $\frac{C_t^{3/2}}{C_p}$
2 BLADE, STND WIDTH, ALL SEC
2 BLADE, WIDE BLADES, RAF 6 SEC
3 BLADE, STND WIDTH, RAF 6 SEC
3 BLADE, STND WIDTH, CLARK Y SEC
C_p

FIG. 2. Single rotation, standard and wide blades (data from reference 7 for tip Mach Number = 0.5).

$$\overline{F.M.} = P/P_a = (0.798)\ (C_t/C_p)^{3/2} \qquad (15)$$

This is the expression used in reference 6 to evaluate unducted propeller static thrust performance. For a ducted configuration having a straight duct, the 0.798 factor is replaced by 0.562.

TEST DATA

Unducted—

The available data (references 7–17) present C_t and C_p vs. propeller blade angle. The figure of merit was computed for each blade angle by picking C_t and C_p values and using Eq. (15). Plots were then made of $\overline{F.M.}$ vs. power coefficient C_p. These $\overline{F.M.}$ data were plotted against C_p rather than blade angle or C_t for the reason that the curves can be used in the practical selection of propellers for static thrust. The power coefficient is simply $P_a/\rho n^3 D^5$. For sea level standard conditions, it can be expressed as

$$C_p = (0.0051)\ BHP/(M_{tip}{}^3 D^2) \qquad (16)$$

In a practical design problem, the *BHP*, diameter, and tip Mach Number are selected. The C_p is then computed from Eq. (16). The curves of $\overline{F.M.}$ vs. C_p can then be entered at this value and a propeller selected which demonstrates a high $\overline{F.M.}$ at this C_p.

Representative figure of merit data are presented in Figs. 2–6. The curves of Fig. 2 were obtained from reference 7. The curves of Figs. 3–6 are from reference 12, and are arranged in order of increasing solidity. It is seen that the $\overline{F.M.}$ remains high with increasing C_p as the solidity is increased, whereas with the low solidities, the $\overline{F.M.}$ drops off rapidly with C_p. It should be noticed that the blade angle for maximum figure of merit tends to increase somewhat with increasing solidity, varying from about 8° at the lowest solidity to 15° at the highest. In all but the lowest solidities, the $\overline{F.M.}$ does not decrease greatly between blade angles of 10° and 15°.

Comparison of the data of Fig. 2 with the data of Fig. 3 for the same propeller configuration indicates differences in $\overline{F.M.}$ for the same C_p. The data of Fig. 2 were taken at a tip Mach Number of 0.5, while the data of Figs. 3–6 were at almost half that tip Mach Number (the tests were limited by the available power). Examination of all the available data on $\overline{F.M.}$ vs. tip Mach Number for comparable conditions shows no clearly defined variation with Mach Numbers less than about 0.8. From the standpoint of propeller weight, it is found desirable to operate at as high a tip Mach Number as can be tolerated before deleterious effects occur. Operating at a tip Mach Number of 0.75 to 0.80 appears reasonable. The operating r.p.m. is thus determined by the diameter from the relationship:

$$M_{tip} = ND/21{,}400 \qquad (17)$$

For a tip Mach Number of 0.8, this expression yields

$$N = 17{,}100/D \qquad (18)$$

Ducted—

Certain test data are available (reference 4) which present the static thrust of ducted propellers in terms of T/BHP vs. BHP/A. An evaluation of the figure of merit using these data can be performed by rearranging Eq. (11) as shown below:

$$\overline{F.M.} = (T/BHP)^{3/2}\ (BHP/A)^{1/2}/(53.7)\sigma^{1/2}\ (A_s/A)^{1/2} \qquad (19)$$

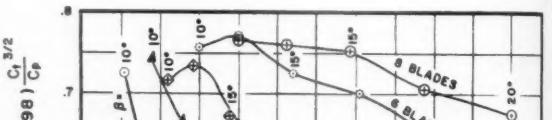

FIG. 3. Single rotation, standard width (data from reference 12).

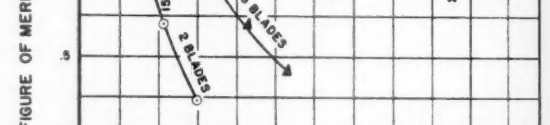

FIG. 4. Single rotation, wide blades (data from reference 12).

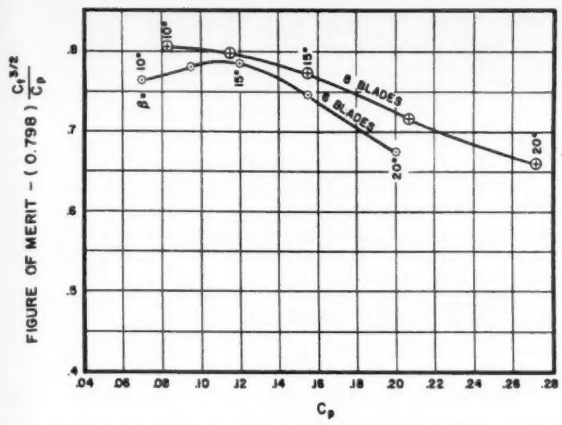

FIG. 5. Dual rotation, standard width (data from reference 12).

Using this expression, the ducted propeller data of reference 4 were evaluated, and an average value of $\overline{F.M.}$ was found to be 0.92 for a well-designed duct-propeller combination. This is considerably in excess of 0.7–0.8 values for an unducted propeller, and indicates how the duct improves the aerodynamic conditions aside from the primary effect of preventing the contraction of the slipstream.

Aside from the data referred to above, there exist even fewer test results on ducted propellers than on unducted propellers.

Flow Visualization—

Very little work has been performed on flow visualization as an aid in understanding the flow involved with a propeller developing static thrust. Reference 18 does make an attempt in this direction by testing a small propeller using balsa dust to visualize the flow. These tests reveal the complex nature of the flow in the static regime. Fig. 1 indicates the general nature of this flow.

A particle of air at a feels the reduced static pressure in front of the propeller and responds by moving in the direction of the streamline shown. Flow visualization studies (reference 18 and unpublished data) indicate that the flow is actually backwards through the propeller at the tip. It is little wonder that attempts at strip analysis, etc., have been relatively futile in attempting to predict accurately, from a purely theoretical standpoint, the static thrust of a propeller.

Examples of Static Thrust Computation

Unducted—

The primary computation performed by the designer in the preliminary design of any propeller driven VTOL aircraft is that of the determination of propeller static thrust. Considerable confusion exists within the industry as to just how this should be done. The following example presents what the author believes to be the most straightforward and simple means of using the available data to predict propeller static thrust.

Given:

(1) Shaft horsepower available per propeller = 1,000

(2) The first trial diameter (consistent with ground clearance, engine r.p.m., etc.) = 10 ft.

(3) Standard sea level conditions

Procedure:

(1) Assuming a tip Mach Number of 0.8, compute C_p using Eq. (16):

$$C_p = (0.0051)\, BHP/M_{tip}{}^3\, D^2 = [(0.0051)\ (1{,}000)]/(\overline{0.8^3}\ \overline{10^2}) = \underline{0.10}$$

(2) Consulting Fig. 3 at a C_p of 0.10, it is seen that the use of an eight blade configuration (standard width blades) will yield the highest figure of merit. Attempting to use fewer blades of standard width will only result in a substantial decrease in the performance. Fig. 4 reveals, however, that a four blade configuration with wide blades will yield a high $\overline{F.M.}$ Even a three blade configuration will not suffer too badly from lack of solidity. Examination of Figs. 5 and 6 indicates that the use of dual rotation will considerably improve the $\overline{F.M.}$

Suppose that the available engine and propeller is such that a single rotation three blade propeller having wide blades must be used. Using Fig. 4, the $\overline{F.M.}$ is 0.685. Eq. (10) can now be used:

$$T = 10.42\ (\overline{F.M.} \cdot D \cdot BHP\ \sigma^{1/2})^{2/3} = 10.42\ [(0.68)\ (10)\ (1{,}000)\ (1)]^{2/3} = \underline{3{,}700}\ \text{lbs.}$$

Using Eq. (10), the r.p.m. can be determined:

$$M_{tip} = ND/21{,}400; \quad N = (21{,}400)\ (0.8)/10 = \underline{1{,}710}$$

The computation indicates that the propeller selected will develop 3,700 lbs. of static thrust using 1,000 shaft horsepower on a standard day at sea level. For altitude or hot day operation, the density ratio, σ, and the power available corresponding to this ambient condition must be used in the equation.

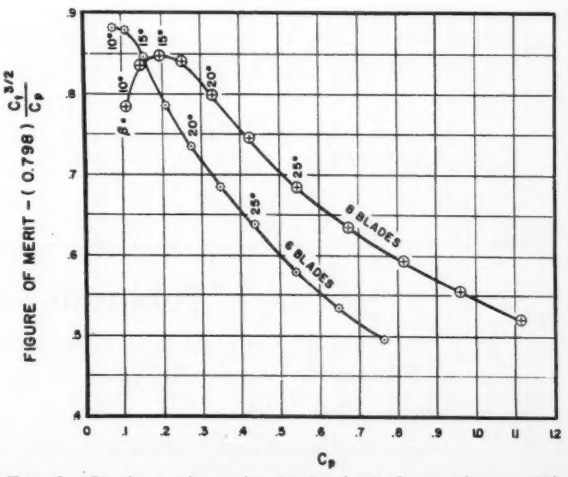

FIG. 6. Dual rotation, wide blades (data from reference 12).

Ducted—

The thrust of a ducted propeller configuration can be computed as follows:

Given:

(1) Shaft horsepower available = 1,000

(2) Diameter of propeller = 8 ft.

(3) Diameter of exit = 9 ft.

(4) Inlet radius at least 6 per cent of the inlet diameter

(5) Standard sea level condition

Procedure:

(1) Using Eq. (11):

$$T = 13.13\ [\overline{F.M.} \cdot D \cdot BHP\sigma^{1/2}\ (A_s/A)^{1/2}]^{2/3}$$

(2) $A_s/A = D_s^2/D_p^2 = (9/8)^2 = 1.26$; $(A_s/A)^{1/2} = 1.125$

(3) $T = 13.13\ [(0.92)\ (8)\ (1000)\ (1)\ (1.125)\ ]^{2/3}$
$= \underline{5{,}350}$ lbs.

This computation indicates that the 8 ft. ducted propeller configuration will produce 5,350 lbs. of static thrust (45 per cent more than the unducted 10 ft. propeller) using 1,000 shaft horsepower on a standard day at sea level.

Conclusions

The basic theory will provide an insight of the fundamental physical nature of the development of static thrust by a propeller. Theoretical prediction of static thrust of propellers must be thoroughly correlated with experimental data, however, to provide a reliable basis for that prediction. The test data which exist at the present time are meager and sometimes contradictory, and must be used with caution. Much more theoretical and experimental investigation needs to be performed.

The methods presented herein and the data which are available at the present time will yield a rapid, simple, and sufficiently accurate determination of static thrust of propellers of conventional design for most preliminary analyses.

References

[1] Coward, Ken S., *Propeller Selection for High Static and Forward Flight Efficiency for VTOL Aircraft*, Aeronautical Engineering Review, Vol. 16, No. 7, pp. 41–43, July, 1957.

[2] Draper, John W., and Kuhn, Richard E., *Investigation of the Aerodynamic Characteristics of a Model Wing—Propeller Combination and of the Wing and Propeller Separately at Angles of Attack Up to 90°*, NACA TN 3304, November, 1954.

[3] Zimmerman, Charles, *Case for Convertible Aircraft*, Av. Week, Vol. 52, No. 1, pp. 18, 21–24, January 2, 1950.

[4] Stone, Arthur, *Shrouded versus Unshrouded Propellers*, U.S. Navy BuAer Report DR-1750.

[5] Parlett, Lysle P., *Aerodynamic Characteristics of a Small Scale Shrouded Propeller at Angles of Attack from 0° to 90°*, NACA TN 3547, November, 1955.

[6] McLenne, H. Clyde, and Cannon, Michael D., *Aerodynamic Investigation of a Four-Blade Propeller Operating Through an Angle of Attack Range from 0° to 180°*, NACA TN 3228, June, 1954.

[7] Bierman, David, *Static Thrust and Power Characteristics of Six Full-Scale Propellers*, NACA TR 684, 1940

[8] Wood, John H., and Swihart, John M., *The Effect of Blade-Section Camber on the Static Characteristics of Three NACA Propellers*, NACA RM L51 L28, 1952.

[9] Platt, Robert J., Jr., *Static Tests of Four Two-Blade NACA Propellers Differing in Camber and Solidity*, NACA RM L 8 H 25 a, 1948.

[10] Platt, Robert J., Jr., *Static Tests of a Shrouded and an Unshrouded Propeller*, NACA RM No. L7H25, 1948.

[11] Dingeldein, Richard C., and Schaefer, Raymond F., *Static Thrust Tests of Six Rotor-Blade Designs on a Helicopter in the Langley Full-Scale Tunnel*, NACA ARR L5F25b, 1945.

[12] Gilman, Jean, Jr., *Static-Thrust and Torque Characteristics of Single and Dual-Rotating Tractor Propellers*, NACA WR L-750, 1944.

[13] Harrington, Robert D., *Full-Scale Tunnel Investigation of the Static-Thrust Performance of a Coaxial Helicopter Rotor*, NACA TN2318, March, 1951.

[14] Carpenter, Paul J., *Effect of Compressibility on the Performance of Two Full-Scale Helicopter Rotors*, NACA TN2277, January, 1951.

[15] Lipson, Stanley, *Static Thrust Investigation of Full-Scale PV-2 Helicopter Rotors Having NACA 0012.6 and 23012.6 Airfoil Sections*, NACA MR No. L6D24, 1946.

[16] Carson, Blake W., Jr., and Mastrocola, Nicholas, *Static Characteristics of Hamilton Standard Propellers Having Clark Y and NACA 16-Series Blade Sections*, NACA WR L-529, August, 1941.

[17] Carson, Blake W., Jr., and Mastrocola, Nicholas, *Static Characteristics of Curtiss Propellers Having Different Blade Sections*, NACA WR L-568, August, 1941.

[18] Taylor, Marion K., *A Balsa Dust Technique for Air—Flow Visualization and its Application to Flow Through Model Helicopter Rotors in Static Thrust*, NACA TN 2220, November, 1950.

[19] Webb, Dana A., and Willer, Jack E., *Propeller Performance at Zero Forward Speed*, WADC Technical Report 52-152, July, 1952.

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Publication Now Available

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The frequency response characteristics of a vane-type angle of attack transducer are quite different from those of the classical vibration system, and the usual curves of amplitude, damping, frequency, and phase lag do not apply.

Frequency Response Analysis of The Vane-Type Angle of Attack Transducer

G. J. Friedman
Servomechanisms, Inc.

SMI'S VANE-TYPE angle of attack transducer was subjected to a series of dynamic tests in one of the supersonic wind tunnels of the Army Ballistic Missile Agency. The results of the step-input dynamic testing were routine and were interpreted by the usual mechanical vibration theory. However, when the frequency response tests were performed, very surprising results were obtained; each time the vane was excited at its natural frequency, its amplitude of vibration, instead of being amplified, would always go to zero. On either side of the natural frequency, the amplitude would asymptotically approach the amplitude of excitation. It was strongly indicated that the standard vibration curves were not applicable.

The purpose of this report is to closely analyze this vane system and to develop a new set of curves which will be useful in the interpretation of frequency response tests in wind tunnels.

DESCRIPTION OF THE SYSTEM

The rotating portion of the instrument consists of a rigid body which aligns itself with the local air stream and which positions a wiper on a potentiometer (see Fig. 1). Damping action takes place whenever relative motion exists between the rotating and stationary parts. The sinusoidal forcing function is applied by means of the rotational oscillation of the instrument case. Therefore, in order for the vane to be affected, the force must be transmitted through the damping fluid.

Fig. 1 indicates three possible reference systems for the independent variable. ϕ, the instantaneous angle between the potentiometer centerline and a stationary reference, is the excitation function. α, the angle between the wiper and the pot centerline, is the electrical output of the transducer. θ, the angle between the vane itself and a stationary reference, is the motion as a person looking through the wind tunnel window would view it. Since all the data were taken in terms of ϕ and α, and since the three variables hold a simple relationship to one another, $\theta = \phi + \alpha$, the final equations of motion are written in terms of ϕ and α only.

Mr. Friedman is Staff Engineer.

SYMBOLS

θ	= Angle between vane and space oriented reference system
ϕ	= Angle between pot ℄ and space oriented reference system
α	= Angle between pot ℄ and pot wiper
I	= Moment of inertia of vane-shaft-counterweight assembly
c	= Damping constant
k	= Equivalent aerodynamic "spring" force
r	= Radius of damping cup
l	= Effective length of vane
T	= Torque
ω	= Harmonic frequency
t	= Time
A	= Linear amplitude of forcing function
ψ	= Phase lag
ω_n	= Undamped natural frequency
C_c	= Critical damping
ζ	= Damping ratio
ϵ	= Frequency ratio
X	= Amplitude of potentiometer output
P_0	= Force amplitude of forcing function
m	= Mass
x	= Independent variable in rectilinear system

DIFFERENTIAL EQUATION AND SOLUTION

Since

$$\alpha + \phi = \theta \tag{1}$$

then

$$\dot{\alpha} + \dot{\phi} = \dot{\theta}$$
$$\ddot{\alpha} + \ddot{\phi} = \ddot{\theta}$$

$$\text{damping torque} = cr^2(\dot{\phi} - \dot{\theta}) = -cr^2\dot{\alpha} \tag{2}$$

$$\text{spring torque} = -kl^2\theta = -kl^2(\alpha + \phi) \tag{3}$$

$$I\ddot{\theta} = I(\ddot{\alpha} + \ddot{\phi}) \tag{4}$$

Using Newton's second law, $\Sigma T = I\ddot{\theta}$ (5)

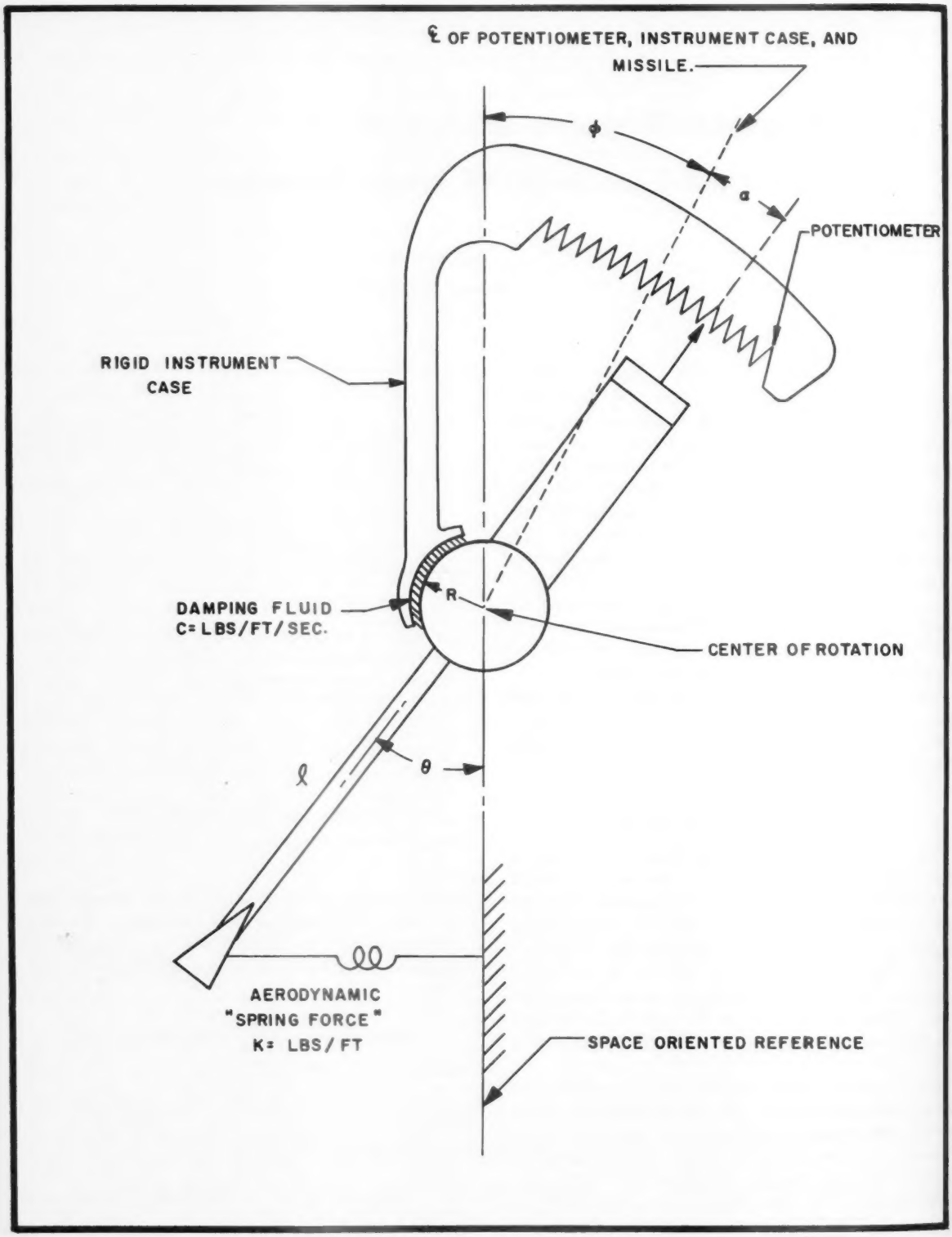

FIG. 1. The angle of attack transducer and its reference systems.

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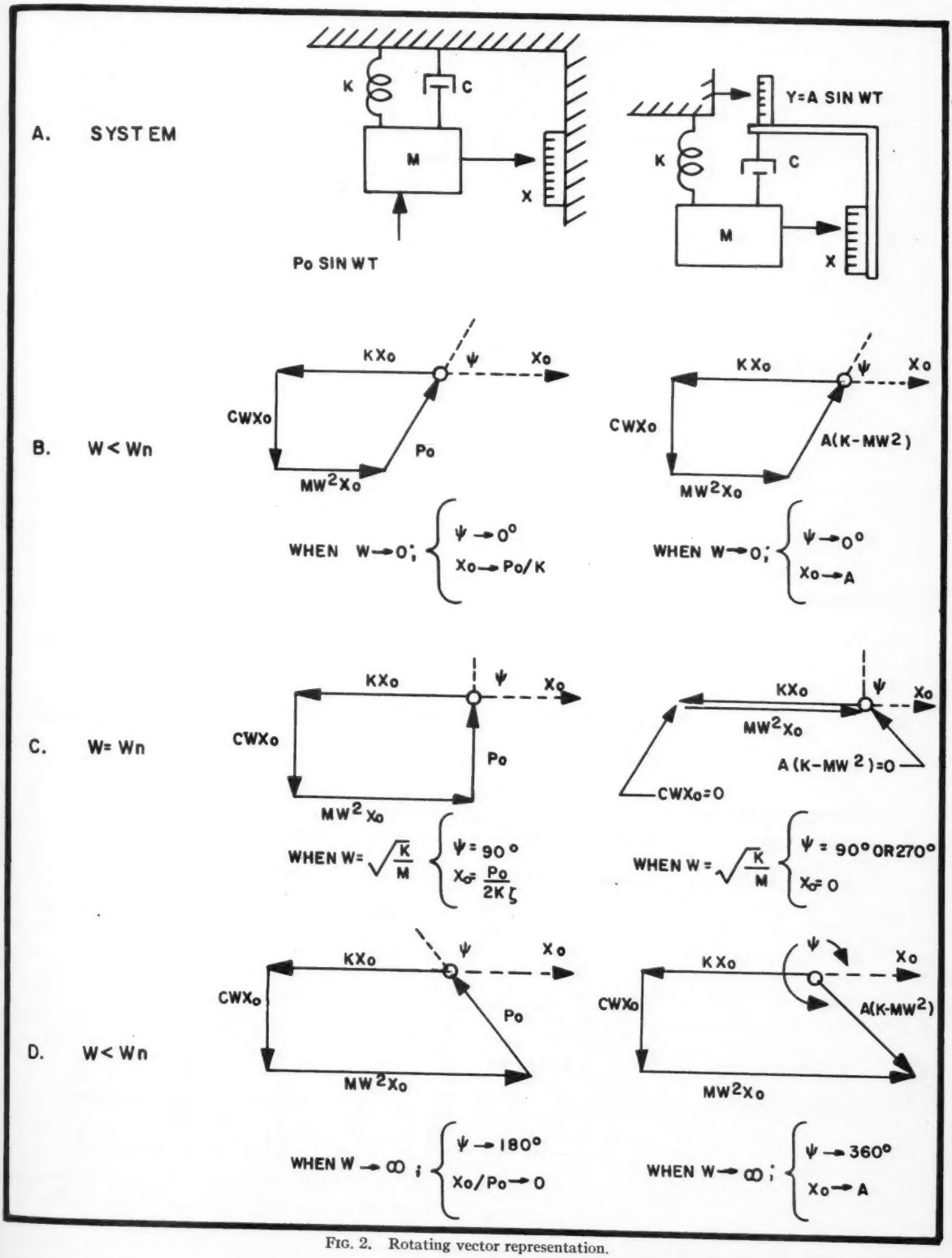

FIG. 2. Rotating vector representation.

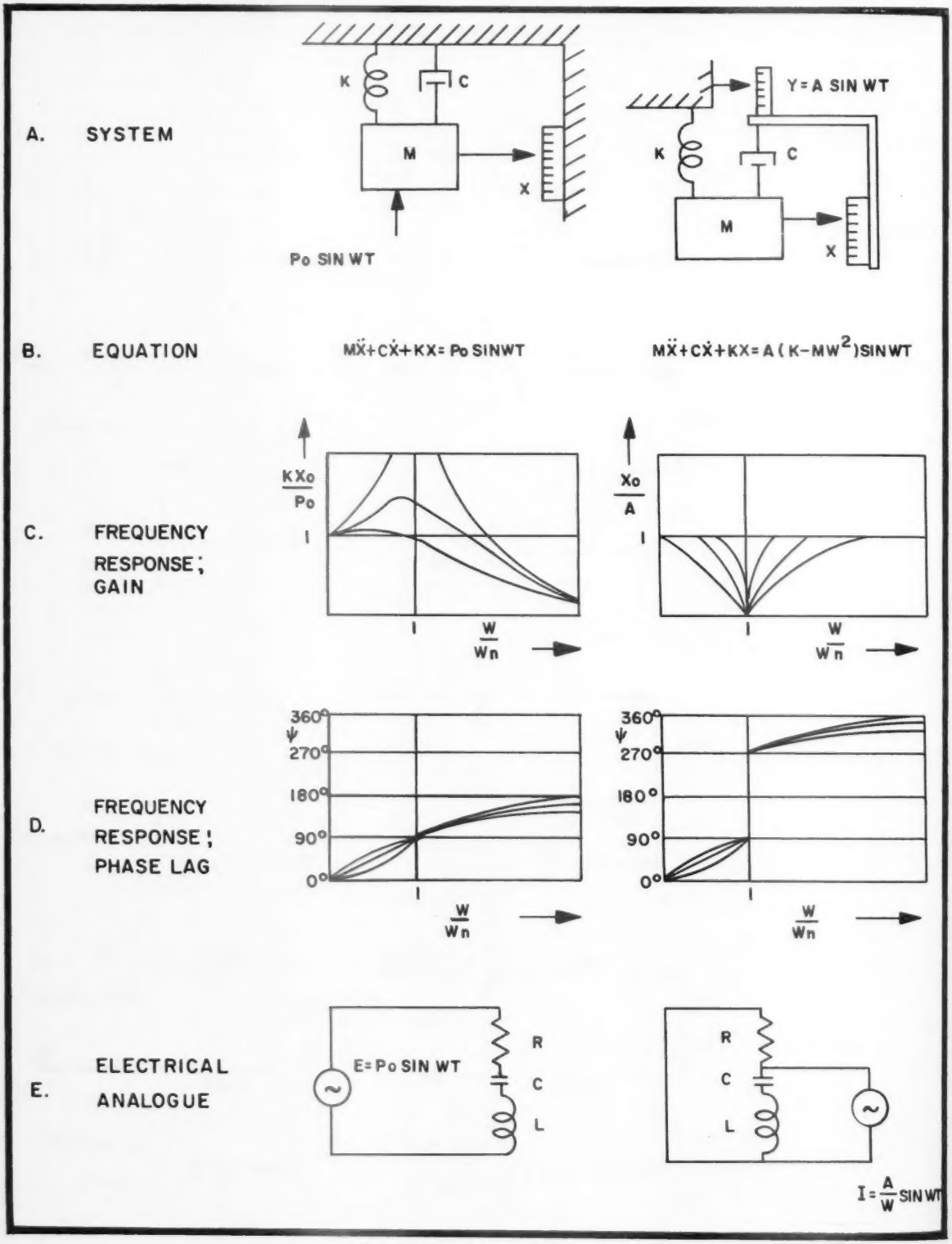

FIG. 3. Comparison of systems.

$$I(\ddot{\alpha} + \ddot{\phi}) + cr^2\dot{\alpha} + kl^2(\alpha + \phi) = 0 \qquad (6)$$

$$I\ddot{\alpha} + cr^2\dot{\alpha} + kl^2\alpha = -I\ddot{\phi} + kl^2\phi \qquad (6a)$$

Thus far, nothing has been said about the nature of the excitation function. Let

$$\phi = -A \sin \omega t \qquad (7)$$

then

$$\ddot{\phi} = \omega^2 A \sin \omega t \qquad (7a)$$

Substituting Eqs. (7) and (7a) into Eq. (6a):

$$I\ddot{\alpha} + cr^2\dot{\alpha} + kl^2\alpha = A(kl^2 - I\omega^2) \sin \omega t \qquad (8)$$

Eq. (8) is the differential equation which describes our system. It is a well-known form and the solution may be written down directly:

$$\alpha = X \sin (\omega t - \psi) \qquad (9)$$

$$X = A(kl^2 - I\omega^2)/[(kl^2 - I\omega^2)^2 + (cr^2\omega)^2]^{1/2} \qquad (9a)$$

$$\psi = \tan^{-1} cr^2\omega/(kl^2 - I\omega^2) \qquad (9b)$$

It will be worth while to put Eqs. (9) in dimensionless form.

Let
$$\left.\begin{aligned} \omega_n &= \sqrt{kl^2/I} \quad C_c = 2I\omega_n \\ \zeta &= cr^2/C_c \quad \epsilon = \omega/\omega_n \end{aligned}\right\} \qquad (10)$$

Substituting Eqs. (10) in (9), and rearranging:

$$X/A = 1/\left\{1 + [2\zeta\epsilon/(1 - \epsilon^2)]^2\right\}^{1/2} = 1/\sqrt{1 + \tan^2 \psi} \qquad (11a)$$

$$\tan \psi = 2\zeta\epsilon/(1 - \epsilon^2) \qquad (11b)$$

Eq. (11a) is accurately plotted in Fig. 4 and at least two intuitive remarks may be made about it. If $\zeta = 0$, then no exciting force can reach the vane itself, and X/A should equal 1 for all frequencies. When $\epsilon = 1$, the forcing frequency equals the vane natural frequency and no relative motion exists between the vane and the case. Thus, the potentiometer output, α, equals zero for all nonzero values of ζ.

Eq. (11b) is in a rather ambiguous form. Since $\tan Z = \tan (Z + 180°)$, any given value of $2\zeta\epsilon/(1 - \epsilon^2)$ will mathematically lead to two distinct phase lag angles. Physical experience with this and other systems indicates that this is not true.

The next section determines which of the possible values of the tangent function apply to the phase lag of our system.

Rotating Vector Representation

A convenient tool for the dynamic analysis of mechanical vibrations is the rotating vector.[1] This method will not only determine the desired phase angle relationships, but serves as a check on past results, and furnishes in many cases a clearer picture of the system dynamics.

Fig. 2 (a) presents two schematic systems. The one on the left is the classical single-degree-of-freedom system treated in all basic textbooks on mechanical vibrations. For the sake of brevity, it will be referred to as the "standard" system from now on. The system on the right is a rectilinearized version of our angle of attack system and will be referred to as the "vane" system.

When $\omega < \omega_n$ the vector diagrams for the standard and the vane systems are quite similar [Fig. 2 (b)]. In each case, the solution was assumed to be:

$$X = X_0 \sin (\omega t - \psi) \qquad (12)$$

and the *displacement* vector X_0 was arbitrarily drawn at zero degrees. The *force* vectors were then drawn: the spring force, (kX_0), 180° from the displacement, the damping force, $(c\omega X_0)$, leading the spring force by 90°, the "inertia force," $(m\omega^2 X_0)$, leading the damping force by 90°, and finally the magnitude of the forcing functions, bringing the force polygon back to zero. It can easily be demonstrated that, as $\omega \to 0$, phase angles go to zero and amplitude ratios go to unity.

When $\omega = \omega_n$ a significant difference appears [Fig. 2 (c)]. The standard system diagram becomes a rectangle, $\psi = 90°$ and $X_0 = P_0/2k\zeta$. Since $A(k - m\omega^2)$ vanishes, the vane system diagram flattens down to the two equal-and-opposite vectors (kX_0) and $(m\omega^2 X_0)$. As ω approaches ω_n from below, ψ approaches 90°; however, as ω approaches ω_n from above, ψ approaches 270°.

By equating the very small vertical sides of the rectangles as $\omega \to \omega_n$

$$\lim_{\omega \to \omega_n} (C\omega X_0) = \lim_{\omega \to \omega_n} A(k - m\omega^2) \qquad (13)$$

therefore

$$\lim_{\omega \to \omega_n} (X_0) = 0$$

This verifies our previous result.

When $\omega > \omega_n$, the diagrams appear similar except for a reversal of one vector [Fig. 2 (a)]. The standard system diagram shows the "inertia force" vector increasing faster than any of the others, causing ψ to vary from 90° to 180° and the amplitude ratio, (X_0/P_0), to approach zero. In the vane system, the vector $A(k - m\omega^2)$ has become negative and is thus shown reversed. As ω increases, it easily follows that ψ will vary from 270° to 360°, and since the inertia and forcing vectors will become much larger than the other two,

$$\lim_{\omega \to \infty} (m\omega^2 X_0) = \lim_{\omega \to \infty} A(k - m\omega^2)$$

therefore

$$\lim_{\omega \to \infty} (X_0) = A \qquad (14)$$

Once more this verifies our previous results.

Thus, we have proved that despite the fact that the standard system and the vane system have the same mathematical expression for the phase lag:

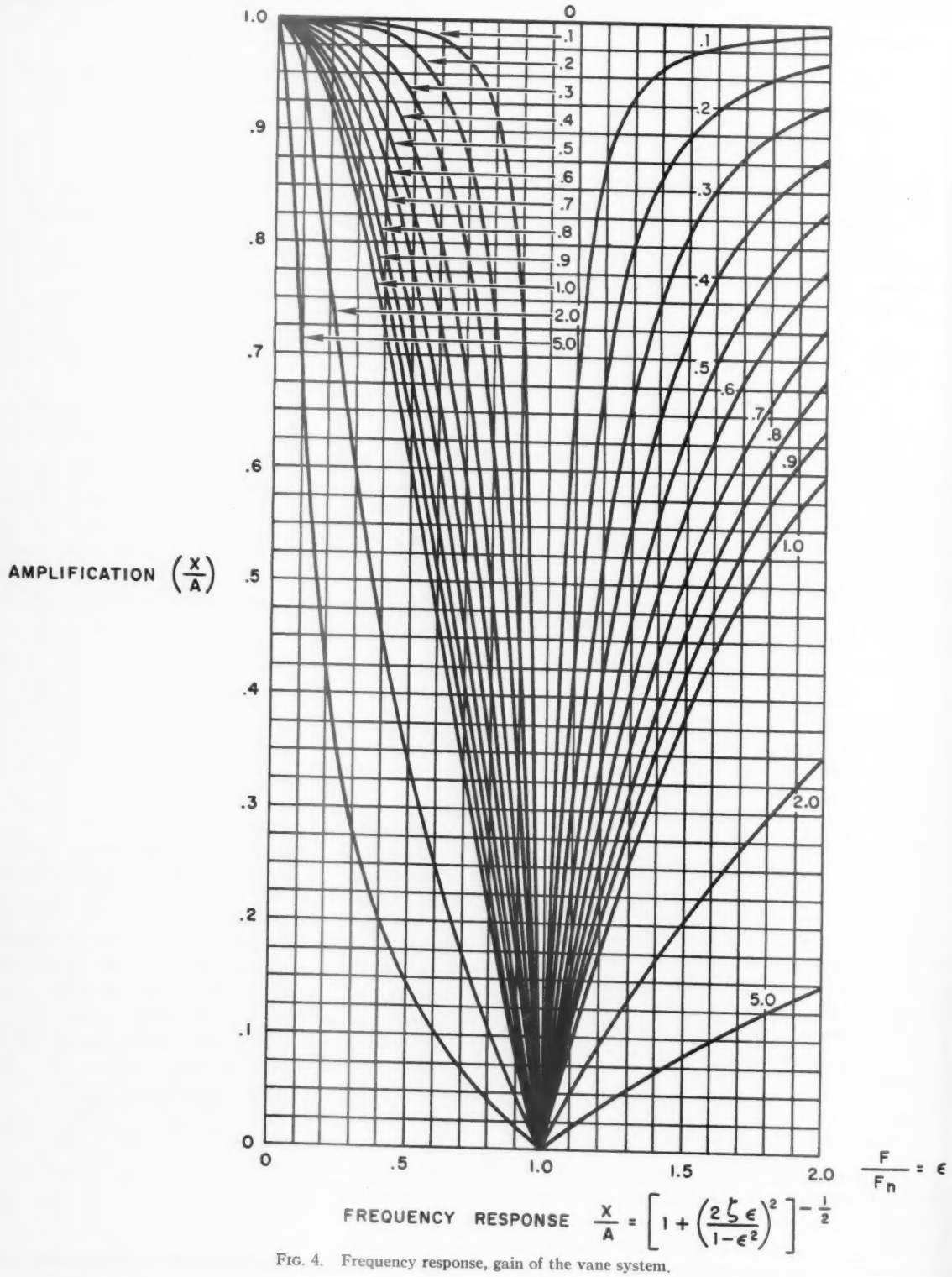

FIG. 4. Frequency response, gain of the vane system.

$$\psi = 2\zeta\epsilon/(1 - \epsilon^2) \qquad (11b)$$

the actual phase relationships are as follows:

	standard	vane system
$\omega < \omega_n$	$0° < \psi < 90°$	$0° < \psi < 90°$
$\omega > \omega_n$	$90° < \psi < 180°$	$270° < \psi < 360°$

Conclusions

When a vane-type angle of attack transducer is sinusoidally excited, its frequency response is drastically different from that of a "standard" system. Fig. 3 furnishes graphic comparisons of the standard and vane systems with respect to schematics, equations, gain, and phase lag vs. frequency, and, finally, electrical analogues.

In evaluating vane systems, Fig. 4 may be used for amplitude ratio or gain interpretation. The standard charts for phase lag may be used for vane systems by merely adding 180° to all phase angles above 90°.

This analysis is valid for angle of attack systems attached to missiles traveling in still or constant velocity air as well as systems tested in wind tunnels. Such situations as when the missile suddenly cuts across a jet stream, or when wind accelerates, fall outside of this analysis.

Reference

[1] Hertog, Den, *Mechanical Vibrations*, 4th Ed., Sections 2 and 15; McGraw-Hill Book Co., Inc., New York, 1956.

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Optical Resection and Inertial Systems (Continued from page 55)

to orbit about the sun, involves only one condition to be satisfied at final thrust termination, and the most general case, that of guiding the vehicle so that it occupies a prescribed point on a prescribed orbit at a prescribed time, requires all six conditions to be satisfied simultaneously. The latter case requires a much more complex computer than the former, and other combinations of specified parameters require, correspondingly, computers of intermediate complexity.

Conclusion

In summary, a pure optical resection system may be used to determine position in interplanetary space with an average precision in position of about 350 miles per sec. of measured angle but with poor precision in velocity determination for steering. An inertial system, on the other hand, may be used to determine velocity for steering with high precision but with poor precision in determining position in long-term flights. An optical resection-inertial system, combining the advantages of both, provides a means for precise navigation and guidance in interplanetary space.

Reference

[1] Carroll, Joel, *Strength of Three Point Resection*, Photogrammetric Engineering, September, 1954.

✦ ✦ ✦

Application of the Hypersonic Similarity Rule (Continued from page 59)

References

[1] Kopal, Z., ed., *Tables of Supersonic Flow Around Cones*, Mass. Inst. of Tech. Report No. 1, 1947.

[2] Feldman, S. R., *Hypersonic Conical Shocks for Dissociated Air in Thermodynamic Equilibrium*, Jet Propulsion, Vol. 27, No. 12, pp. 1253–1255, December, 1957.

[3] Romig, Mary F., *Conical Flow Parameters For Air In Dissociation Equilibrium: Final Results*, Convair Scientific Research Laboratory Research Note 14, January, 1958.

[4] Dorrance, W. H., *Three Dimensional Hypersonic Flow Similarity Parameters*, Convair Report ZA-7-001, September, 1951.

[5] Taylor, G. I., and Maccoll, J. W., *The Air Pressure on a Cone Moving at High Speeds*, Proc. Royal Soc., Ser. A, Vol. 139, p. 278, 1933.

[6] Logan, J. G., and Treanor, C. E., *Tables of Thermodynamic Properties of Air from 3000°K.–10,000°K. at Intervals of 100°K.*, Cornell Aeronautical Laboratory Report No. BE-1007-A-3, January, 1957.

[7] Hochstim, Adolf, *Gas Properties Behind Shocks at Hypersonic Velocities. I. Normal Shocks in Air*, Convair Report ZPh(GP)-002, January, 1957.

[8] Blackwell, F., et al., *Properties of Argon-Free Air*, Ramo-Wooldridge Corp. Report GM-TR-76, October 1, 1956.

[9] Zienkiewicz, H. K., *Flow About Cones at Very High Speeds*, Aero. Quart., Vol. 8, Pt. 4, pp. 384–394, November, 1957.

[10] Linnell, R. D., and Bailey, J. Z., *Similarity-Rule Estimation Methods for Cones and Parabolic Noses*, Journal of the Aeronautical Sciences, Readers' Forum, Vol. 23, No. 8, pp. 796–797, August, 1956.

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Acoustics, Sound, Noise

On the Scattering of Sound by a Nonuniform Surface. Iu. P. Lysanov. *Sov. Phys.-Acous.*, Jan.-Mar., 1958, pp. 45–49. Translation. Presentation of a method for solving an infinite system of algebraic equations derived earlier in order to determine the complex amplitudes of waves which are scattered by a plane nonuniform surface with a periodically varying acoustic admittance.

Sound Radiation of a System with a Finite or an Infinite Number of Resonances. Eugen Skudryzk. *ASA J.*, Dec., 1958, pp. 1,152–1,158. Investigation to determine the sound-radiating elements of a complex mechanical system, to analyze the energy contributions of each element, and to add together the energies of each element.

Diffraction and Radiation of Acoustic Waves in Liquids and Gases. II. M. D. Khaskind. *Sov. Phys.-Acous.*, Jan.-Mar., 1958, pp. 91–99. Translation. Application of a quadratic approximation to establish general formulas for the mean values of the hydrodynamic forces and moments acting on a body when acoustic waves are diffracted and radiated in liquids or gases.

Noise Levels in the Caravelle During Flight. L. N. Miller and L. L. Beranek. *Noise Control*, Sept., 1958, pp. 19–21. Evaluation showing that the average inside noise levels are generally lower than those of most present-day commercial airliners.

I—Sound Emerges as Major Jet Problem. II—Designers Weigh Quiet vs. Cost Penalty. D. A. Anderton. *Av. Week*, Dec. 29, 1958; Jan. 5, 1959, pp. 48–51; 55, 57–65 (ff.). Description of the noise phenomenon, the measurement and the effects of sound intensity, and the development in noise suppression research.

On the Acoustic Field of Turbo Reactors. M. Kobrynski. (*La Recherche Aéronautique*, July-Aug., 1957, pp. 29–35.) *Gt. Brit., RAE Lib. Transl. 775*, Oct., 1958. 13 pp.

Laboratory Simulation of Rocket Engine Noise. M. T. Anderson and L. L. Robinson. *Environmental Quart.*, 4th Quart., 1958, pp. 7–9, 20, 24, 25, 28, 32. Development of an acoustic facility to simulate rocket noise in order to test components for the Titan ICBM nose cone.

Markljuddämpare för Reaktionsflygplan. E. Sassarsson. *Tek. Tidskrift*, Oct. 21, 1958, pp. 987–989. In Swedish. Description of a ground silencer installation for jet aircraft.

Sound-Induced Vibration. P. W. Smith, Jr. *Noise Control*, Nov., 1958, pp. 16–21, 45. 10 refs. Presentation of graphs for evaluating the amplitude of response to high intensity sounds of single frequency in some particular cases of a flexibly mounted, rigid device.

Vibration and Acoustical Problems in Missiles. Jack Evans. *Noise Control*, Nov., 1958, pp. 22–26, 48. Outline of techniques for protecting ballistic missile structure and components from the severe vibrational environment without excessive weight penalty.

Some Considerations Relative to Acoustically Induced Structural Fatigue in a Supersonic Transport Aircraft. G. L. Getline. *IAS 27th Annual Meeting, New York, Jan. 26–29, Rep. 59-19.* 11 pp. Members, $0.50; nonmembers, $1.00. Brief review of the problem as it exists in present day jet aircraft. Structural design practice and its limitations are examined, and design requirements are discussed.

Vibrations of a System with a Finite or an Infinite Number of Resonances. E. J. Skudrzyk. *ASA J.*, Dec., 1958, pp. 1,140–1,152. 20 refs. Study based on the general differential equation of a mechanical system. Driving force and solution are expressed as system without dissipation.

On the Fatigue of Structures Due to Vibrations Excited by Random Pressure Fields. Alan Powell. *ASA J.*, Dec., 1958, pp. 1,130–1,135. Analysis based on the assumption that the forced modes of vibration of a structure subjected to pressure fluctuations, random in time and space, can be approximated by the composition of the motions of the uncoupled natural modes.

Minimizing Damage from Random Vibration. R. M. Mains. *ASA J.*, Dec., 1958, pp. 1,127–1,129. Discussion of problems in relay contact arm chatter, gyro precession, noise generation, and stress fatigue in a structure.

On the Approximation to the "Infinite" Solution by the Method of Normal Modes for Random Vibrations. Alan Powell. *ASA J.*, Dec., 1958, pp. 1,136–1,139.

Reliability a Major System Problem. F. J. Ruther. *Mil. Electronics*, Nov., 1958, pp. 14–18. Discussion of statistical relationships needed to design greater reliability into equipment.

Aerodynamics, Fluid Mechanics

Aerothermodynamics

A Survey and Correlation of Data on Heat Transfer by Forced Convection at Supersonic Speeds. R. J. Monaghan. *Gt. Brit., ARC R&M 3033* (Sept., 1953) 1958. 43 pp. 65 refs. BIS, New York, $2.70.

On Slip-Flow Heat Transfer to a Flat Plate. R. A. Oman and R. A. Scheuing. *J. Aero/Space Sci.*, Feb., 1959, pp. 126, 127. Analysis showing that the assumptions involved in the use of Maslen's expression appear to account for the predominant slip flow effects.

On the Contribution of Thermal Creep to the Skin Friction in Slip Flow. A. F. Charwat. *J. Aero/Space Sci.*, Feb., 1959, pp. 120, 121. Analysis showing that at typical altitudes and for high temperature gradients, the "thermal strain" increases the skin friction by about 5 per cent at 20,000 ft./sec. flight speed, and that it can be as high as 50 per cent of the slip-flow friction under certain conditions.

Supersonic Airfoil Performance with Small Heat Addition. Artur Mager. (*IAS 26th Annual Meeting, New York, Jan. 27–30, 1958, Preprint 768.*) *J. Aero/Space Sci.*, Feb., 1959, pp. 99–107.

Experimental Investigations of the Effect of Heat Transfer on Hypersonic Turbulent Boundary-Layer Skin Friction. E. M. Winkler and M. H. Cha. *J. Aero/Space Sci.*, Feb., 1959, pp. 123, 124. USAF-Navy-sponsored investigation of turbulent boundary-layer, skin-friction, and heat-transfer coefficients for various heat-transfer rates, and analysis of the adequacy of existing theoretical approaches to the problem. Comparison of experimental results with theoretical predictions is made.

Come Vincere il Muro del Calore; Proposta di Studio di un Sistema per Ridurre la Temperatura Superficiale e la Resistenza al Moto degli Aeroplani Supersonici. Nicola Morasca. *Riv. Aero.*, Oct., 1958, pp. 1,499–1,507. In Italian. Study of the heat-barrier problem and discussion of a system for reducing the surface temperature of supersonic aircraft. Includes experimental verification of the system, evaluation of its advantages, and application to rocket vehicles and missiles.

Boundary Layer

Practical High Lift Systems Using Distributed Boundary Layer Control. J. J. Cornish, III. *IAS 27th Annual Meeting, New York, Jan. 26–29, 1959, Rep. 59-18.* 15 pp. Members, $0.50; nonmembers, $1.00. Description of a boundary layer control system and the flight characteristics of three aircraft using the system.

A Rapid Method for Estimating Grit Size for Fixing Transition on Wind-Tunnel Models. J. M. Bidwell. *J. Aero/Space Sci.*, Feb., 1959, pp. 118, 119.

Drag of a Rotating Rough Disc. L. A. Dorfman. *Sov. Phys.-Tech. Phys.*, Feb., 1958, pp. 353–360. Translation. Application of semi-empirical methods to the solution of impulse equations in order to determine the elements of the turbulent boundary layer on a rotating rough disc.

Flow of Fluids

Annual Progress Report. *UTIA APR*, Oct., 1958. 123 pp. 133 refs. Summarized review of research covering mechanics of rarefied gases, aerodynamic noise, dynamics of flight, and other related subjects.

Pressure Exchange. J. V. Foa. *Appl. Mech. Rev.*, Dec., 1958, pp. 655–657. 45 refs. Description and evaluation of various pressure exchange systems. Steady-flow, quasi-static, and wave exchange are discussed.

The Replacement of Lifting Surfaces by Lifting Lines with Variable Position. A. Van Tuyl. *J. Aero/Space Sci.*, Feb., 1959, pp. 127, 128. Investigation showing that, under certain conditions, the replacement problem holds true when $1/x^4$ is replaced by $1/x^3$.

A Note on the Interpretation of Base Pressure Measurements in Supersonic Flows. R. C. Hastings. *Gt. Brit., ARC CP 409*, June, 1958. 19 pp. 22 refs. BIS, New York, $0.54.

Preliminary Investigations of Spiked Bodies at Hypersonic Speeds. S. M. Bogdonoff and I. E. Vas. (*Princeton U. Dept. Aero. Eng. Rep. 412*, Mar., 1958.) *J. Aero/Space Sci.*, Feb., 1959, pp. 65–74. 21 refs.

The Viscous Flow Near a Stagnation Point When the External Flow Has Uniform Vorticity. J. T. Stuart. *J. Aero/Space Sci.*, Feb., 1959, pp. 124, 125.

Hypersonic Viscous Flow Over Slender Cones. Appendix A—**"Modified Tangent Cone" Method.** Appendix B—**Probstein's Analysis for the Self-Induced Pressure Effect.** L. Talbot, T. Koga, and P. M. Sherman. (*U.S., NACA TN 4327*, Sept., 1958.) *IAS 27th Annual Meeting, New York, Jan. 26–29, 1959, Rep. 59-1.* 15 pp. 26 refs. Members, $0.50; nonmembers, $1.00.

Pressure Distributions on Blunt-Nosed Cones in Low Density Hypersonic Flow. L. Talbot, S. A. Schaaf, and F. C. Hurlbut. *Jet Propulsion*, Dec., 1958, pp. 832–834. Investigation of the effect of viscous interaction on the surface pressure.

K Teorii Nelineinykh Kolebanii Ogranichennogo Ob'ema Zhidkosti. N. N. Moiseev. *Prikl. Mat. i Mekh.*, Sept.-Oct., 1958, pp. 612–621. In Russian. Calculation of nonlinear oscillations of a liquid bounded by a cavity.

Two-Dimensional Incompressible Magneto-hydrodynamic Flow Across an Elliptical Solenoid. N. H. Kemp and H. E. Petschek. (*Avco Res. Lab. RR 26*, Apr., 1958.) *J. Fluid Mech.*, Nov., 1958, pp. 553–584.

A Note on Magneto-Hydrodynamics of a Finite Rotating Disk. S. K. Majumdar. *ZAMP*, Nov. 25, 1958, pp. 387–389. Analysis showing that for a rotationally symmetric steady hydromagnetic field the radial component of the magnetic field can be neglected in comparison with the field along the axis of rotation if the depth of the liquid column is small compared with the radius of the disc.

On the Thermal Instability of a Rotating Fluid Sphere. F. E. Bisshopp. *Philos. Mag., 8th Ser.*, Dec., 1958, pp. 1,342–1,360. 11 refs. Development of a method of solution taking into account the full set of boundary conditions. The cases when the bounding sphere is rigid and when it is free are treated. The Rayleigh-Ritz method of approximating lowest characteristic values is used to calculate the critical Rayleigh Number as a function of the Taylor Number.

Postroenie Tochnykh Reshenii Uravnenii Odnomernoi Gazodinamiki pri Nalichii Razryvov. E. V. Riazanov. *Prikl. Mat. i Mekh.*, Sept.-Oct., 1958, p. 720. In Russian. Derivation of exact solutions for the equations of gas dynamics in the presence of shocks.

Temperature Measurements of Shock Waves by the Spectrum-Line Reversal Method. J. G. Clouston, A. G. Gaydon, and I. I. Glass. *Royal Soc. (London) Proc., Ser. A*, Dec. 9, 1958, pp. 429–444. 27 refs. Application of the sodium-line reversal technique using a photomultiplier and cathode-ray oscillograph for time-resolved studies of temperature behind shock waves produced by a bursting diaphragm. General agreement between calculated and observed temperatures is obtained, but both air and oxygen show a high-temperature region due to burning at the interface with the hydrogen driver gas.

O Tolshchine Zony Turbulentnogo Peremeshivaniia na Granitse Dvukh Potokov Gaza Raznoi Skorosti i Plotnosti. O. V. Iakovlevskii. *AN SSSR Otd. Tekh. Nauk Isv.*, Oct., 1958, pp. 153–155. In Russian. Calculation of the thickness of the turbulent mixing zone on the boundary between two jets having different velocity and density.

Internal Flow

A Generalized Porous-Wall "Couette-Type" Flow. K. R. Cramer. *J. Aero/Space Sci.*, Feb., 1959, pp. 121, 122. Theoretical analysis of a "Couette-type" flow, subjected to constant suction or blowing, between a stationary flat surface and a slightly inclined flat plate moving at a constant velocity.

Mixed-Flow Impellers Enter Air-Moving Field. Ch. A. Hathaway. *Prod. Eng.*, Jan. 5, 1959, pp. 56–59. Description of a new type of impeller superior to conventional axial and centrifugal types. A performance comparison is made and air-conditioning needs are analyzed.

An Approximate Method of Determining the Slip Factor of the Radial Outward-Flow Impellers. Masaaki Shirakura. *JSME Bul.*, No. 2, 1958, pp. 171–178. Presentation of an approximate method for calculating the velocity distribution from which the pressure distribution, torque, and slip factor are derived.

Study of Three-Dimensional Internal Flow in Impellers of Centrifugal Blowers with Straight-Radial Blades and Logarithmic-Spiral Blades in Radial Part Only. Kunio Fujie. *JSME Bul.*, Aug., 1958, pp. 275–282. Study of the flow direction and of velocity distribution for two types of impellers. A comparison of theoretical and experimental results is made.

Laminar Flow in a Uniformly Porous Channel. F. M. White, Jr., B. F. Barfield, and M. J. Goglia. (*ASME Annual Meeting, New York, Nov. 30-Dec. 5, 1958, Paper 58-A-19.*) *J. Appl. Mech.*, Dec., 1958, pp. 613–617. Presentation of a general solution of the Navier-Stokes equations for flow between porous parallel plates.

The Development of a Variable-Mach-Number Effuser. Appendix I—**Facilities and Technique.** Appendix II—**The Design of an Effuser for the Range Up to Mach Number 1.6.** Appendix III—**Extension of the Mach-Number Range.** J. B. McGarry. *Gt. Brit., ARC R&M 3097* (Aug., 1957) 1958. 15 pp. BIS, New York, $0.99.

The Use of Helium for Cooling Nozzles Exposed to High Temperature Gas Streams. Antonio Ferri and P. A. Libby. *Polytech. Inst. Bklyn., Dept. Aero. Eng. & Appl. Mech. Rep. (USAF WADC TN 55-318) [AD 94314]*, Nov., 1958. 18 pp. Theoretical and experimental investigation showing helium to be an appropriate insulating gas because of its high sonic velocity and chemical inertness. Indications are that the method should be applicable over a wide range of stagnation conditions.

Tabulation of Coordinates for Hypersonic Axisymmetric Nozzles. I—Analysis and Coordinates for Test Section Mach Numbers of 8, 12 and 20. R. J. Cresci. *Polytech. Inst. Bklyn., Dept. Aero.*

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Eng. & Appl. Mech. Rep. (USAF WADC TN 58-300, Pt. I) [AD 204213], Oct., 1958. 61 pp.

On the Discontinuity in the Velocity of a Water Jet. L. F. Vereshchagin, A. A. Semerchan, and F. M. Filler. *Sov. Phys.-Tech. Phys.*, Feb., 1958, pp. 408–412. Translation. Application of a movie camera to the study of a jet indicating that the jet is stable when the issuing conditions are stable. If the reservoir is too small, the discharge conditions then become unstable, as does the jet.

A Three-Dimensional Flow Expander as a Device to Increase the Mach Number in a Supersonic Wind Tunnel. R. J. Salmi. *U.S., NASA Memo. 10-6-58E*, Dec., 1958. 7 pp. Investigation of a simple 5° conical-flow expander to determine the feasibility of using this type of device to increase the Mach Number in the test section of a supersonic wind tunnel.

On the Theory of the Evaporation of Small Droplets. N. A. Fuks. *Sov. Phys.-Tech. Phys.*, Jan., 1958, pp. 140–143. 16 refs. Translation. Derivation of an expression for the rate of evaporation in a gaseous medium of drops whose radius r is comparable with the mean free path λ of a vapor molecule. This expression is applicable for any value of the ratio λ/r.

Stability & Control

Critical Flight Conditions and Loads Resulting from Inertia Cross-Coupling and Aerodynamic Stability Deficiencies. Appendix I—**The Stability of the Rolling Aircraft with Inertia Cross-Coupling.** Appendix II—**Autorotational Rolling.** Appendix III—**Control Required to Prevent Pitch and Yaw Building Up in Inertia-Coupled Rolling.** Appendix IV—**Pitch Up Response with Pilot's Counter Control.** Appendix V—**Aircraft Response in Self-Stabilizing Pitch Up.** W. J. G. Pinsker. *Gt. Brit., ARC CP 404* (Mar., 1957) 1958. 44 pp. BIS, New York, $1.08.

Eine Untersuchung der dynamischen Längsstabilität eines Flugzeugs mit Hilfe des Wurzel-Ortskurven-Verfahrens. Wilfried Heins. *ZFW*, Nov., 1958, pp. 309–314. In German. Evaluation of the root-locus method and description of its application to flight mechanics. The specific case studied is that of the dependence of the dynamic longitudinal stability of a glider on the steady-state flight velocity and the location of the center of gravity.

Experimental Wind-Tunnel Investigation of the Transonic Damping-in-Pitch Characteristics of Two Wing-Body Combinations. H. F. Emerson and R. C. Robinson. *U.S., NASA Memo. 11-30-58A*, Dec., 1958. 26 pp. Test results showing that for the models tested the maximum values of the damping in pitch occur at Mach Numbers very close to 1.0, and that changes in the pitch damping are encountered near sonic velocity.

Wings & Airfoils

Experimental Investigation of a Thick Laminar Airfoil. B. H. Carmichael. *Soaring*, Nov.-Dec., 1958, pp. 6–10. 11 refs. Description of the test facilities and model. The advantages and disadvantages of thick laminar airfoils are discussed and the performance characteristics of the basic airfoil given. A comparison of four thick airfoils is made.

Chordwise Variation of Position of Maximum Thickness of a Symmetrical Hyperbolic Aerofoil Profile. P. A. Vasavada. *Aero. Soc. India J.*, Aug., 1958, pp. 50–55. Study made in order to gain some control on the position of maximum thickness along the chord of an airfoil profile. Control is exercised by introduction of singularities in the so-called S-plane which is related to the hodograph plane.

Observations of the Flow Past a Two-Dimensional 4 per cent Thick Biconvex Aerofoil at High Subsonic Speeds. B. D. Henshall and R. F. Cash. *Gt. Brit., ARC R&M 3092* (Feb., 1957) 1958. 17 pp. BIS, New York, $1.17. Analysis of flow photographs and pressure distributions to determine the onset of separation effects.

Observations of the Flow Patterns of a Two-Dimensional 4 per cent Thick Biconvex Aerofoil at M_0 = 1.40 and 1.63. B. D. Henshall and R. F. Cash. *Gt. Brit., ARC R&M 3093* (June, 1957) 1958. 9 pp. BIS, New York, $0.63. Presentation of direct-shadow and schlieren photographs as well as pressure distributions of the flow past an airfoil for a limited range of incidences. Particular attention is given to the presence of shock-induced boundary-layer separation at the trailing edge of the airfoil.

Basic Pressure Measurements at Transonic Speeds on a Thin 45° Sweptback Highly Tapered Wing with Systematic Spanwise Twist Variations; Untwisted Wing. J. P. Mugler, Jr. *U.S., NASA Memo. 10-20-58L*, Dec., 1958. 93 pp. Presentation of pressure distributions for Mach Numbers from 0.8 to 1.2 through an angle-of-attack range of −4° to 12°.

A Similarity Law for the Normal Force on a Delta Wing at Hypersonic Speeds. A. F. Messiter. *J. Aero/Space Sci.*, Feb., 1959, pp. 119, 120. Derivation of equations describing the consistent second approximation and of a similarity law for the normal-force coefficient.

Velocity Distribution on Thin Tapered Arrowhead and Delta Wings with Spanwise Constant Thickness Ratio at Zero Incidence. S. Neumark, J. Collingbourne, and E. J. York. *Gt. Brit., ARC R&M 3008* (May, 1955) 1958. 37 pp. BIS, New York, $2.34.

Aeroelasticity

A Method of Equating Long Duration-Low Intensity and Short Duration-High Intensity Random Vibration. A. J. Curtis. *SAE Natl. Aero. Meeting, Los Angeles, Sept. 29–Oct. 4, 1958, Preprint 83C.* 5 pp.

Power Spectral Analysis of Sled Vibration Data. H. R. Lotze. *USAF MDC TN 58-12 [AD 154106]*, Sept., 1958. 29 pp. Description of (AF MDC) facilities for spectral analysis and comparison of the various methods. An explanation is given of the calibration of analyzers and of the data processing equipment.

O Poperechnykh Kolebaniiakh Sterzhnei. M. Sh. Flekser. *Prikl. Mat. i Mekh.*, Sept.-Oct., 1958, pp. 696–700. In Russian. Derivation of a system of differential equations for calculating the lateral vibrations of bars.

Free Lateral Vibrations of Rectangular Bars with Many Circular Holes. II. Shin Takahashi. *JSME Bul.*, Aug., 1958, pp. 210–215.

Vibration of Corrugated Diaphragm. Takashi Akasaka and Toshio Takagishi. *JSME Bul.*, Aug., 1958, pp. 215–221. Analysis of the natural frequencies of the corrugated diaphragm and derivation of the approximate formulas for the lower order frequencies of symmetric and asymmetric modes including the effect of the concentrated mass.

The Problem of Vibration of Non-Automatic Systems with Strong Non-Linearity. J. Skowroński and S. Ziemba. *Arch. Mech. Stosowanej*, No. 4, 1958, pp. 515–523. 12 refs. Generalization of the "D-class" notion for a system of one degree of freedom to systems of any finite number of degrees of freedom.

Aeronautics, General

Industry's Viewpoint on the Challenge of Space Technology to Aeronautical Engineering. Grayson Merrill. *IAS 27th Annual Meeting, New York, Jan. 26–29, 1959, Rep. 59-15.* 7 pp. Members, $0.50; nonmembers, $1.00.

The Space Age Effect on Management. E. A. Ledeen. *(IAS 27th Annual Meeting, New York, Jan. 26–29, 1959.) Aero/Space Engrg.*, Feb., 1959, pp. 29, 58. Discussion of various problems encountered with the advent of space flight.

Air Transportation

Towards Practical Airpackaging. A. J. Mason. *Air Transp.*, Dec., 1958, pp. 14, 21–23. Discussion of Air Force packaging methods to reduce the span of time between the need for a commodity and its ultimate delivery in safe condition.

Unleashing Air Freight's Potential. E. W. Fuller and R. F. Stoessel. *SAE Natl. Aero. Meeting, Los Angeles, Sept. 29-Oct. 4, 1958, Preprint 86C.* 14 pp. Discussion of the factors affecting utilization, particularly of cargo airplanes, and analysis of the effects of variations in elapsed time allowed for maintenance, loading, and refueling.

Possible Methods of Reducing Aircraft Operating Costs. L. G. Randlesome. *Can. Aero. J.*, Nov., 1958, pp. 320, 321. Discussion on the savings made possible by changing acceptance standards and introducing repair schemes as experience dictates.

Airplanes

Air Conditioning, Pressurization

Air Conditioned Comfort on the Douglas DC-8 Jet Transport. A. A. Hershfield. *SAE Natl. Aero. Meeting, Los Angeles, Sept. 29-Oct. 4, 1958, Preprint 87A.* 13 pp. Description of the DC-8 air conditioning system. A brief history of the progress realized in this field is given.

Air Conditioning the Lockheed Electra. J. G. Krisilas and E. S. McCarthy. *(SAE Natl. Aero. Meeting, Los Angeles, Sept. 29-Oct. 4, 1958, Preprint 87C.) SAE J.*, Dec., 1958, pp. 58–62.

Emergency Passenger Oxygen System. Walter Kidde. *SLAE J.*, Nov., 1958, pp. 2–4. Description of the system installed in Britannia and Comet transports.

Control Systems, Automatic Pilots

The SC.1's Autostabiliser System. *Shorts Quart. Rev.*, Dec., 1958, pp. 13–16. Discussion on the working principles and functions of the autostabilizer.

Attitude Control. Eric Burgess. *Missile Des. & Devel.*, Nov., 1958, pp. 12–16, 31. Discussion covering auxiliary thrust units and deflection of the main power plant as a means of attitude control.

All-Attitude Automatic Pilots. E. R. Tribken. *Sperry Eng. Rev.*, June, 1958, pp. 27–32. Definition of the all-attitude automatic pilot, and presentation of its differences from limited-attitude devices. The various reference systems and their components are discussed along with their respective advantages and disadvantages.

Automatic Flare Systems for Aircraft, Missiles, and Space Vehicles. E. R. Buxton. *SAE Natl. Aero. Meeting, Los Angeles, Sept. 29-Oct. 4, 1958, Preprint 88C.* 18 pp. Review of current flare landing systems, and analysis of a new system better suited for the latest requirements, called the path program system.

Control and Stabilization System Reliability. W. I. Stieglitz. *(NATO AGARD Flight Test Panel, Paris, Apr. 21–25, 1958.) NATO AGARD Rep. 193*, Apr., 1958. 22 pp. 25 refs. Discussion of design, ground testing, and flight testing of control and stabilization systems with a comparison of past and present system requirements.

Description

Debut for the Caribou. *Aircraft* (Canada), Oct., 1958, pp. 16–20, 78. Design characteristics of the de Havilland DHC-4 STOL transport.

Britannias for the Military Role; Features of the 252 and 253. *Shorts Quart. Rev.*, Dec., 1958, pp. 9–12.

Performance Tests on Dakota Aircraft Powered by SIC3G Engines. S. Ramamritham and M. S. Ekbote. *Aero. Soc. India J.*, Aug., 1958, pp. 37–50.

Konstruktionsgrundsätze und technische Merkmale der Vickers "Vanguard." N. A. Barfield. *Luftfahrttechnik*, Oct. 15, 1958, pp. 280–285, cutaway drawings. In German. Comprehensive survey of the development of the Vickers Vanguard transport, including data on fuselage and wing construction, power plants, fuels, hydraulic and pneumatic systems, electric and control systems, as well as safety considerations.

Design

SeaMaster—Design Concepts. J. P. Kushnerick. *Aircraft & Missiles Mfg.*, Dec., 1958, pp. 33–37.

The Mechanical Engineering of Aircraft Mechanisms. R. O. Jones. *Chartered Mech. Engr.*, Dec., 1958, pp. 488–500. Discussion of the design, production, and suitability for maintenance of variable-pitch propellers, power controls, and retractable undercarriages.

Vanguard—First Survey. I—Vickers' Second Generation Turboprop. II—Engineering the Vanguard. III—Turboprop Power By Tyne. *The Aeroplane*, Dec. 19, 1958, pp. 887–901, cutaway drawing. Discussion of design development; structural, performance, and aerodynamic characteristics; systems; and power plants of the British turboprop transport.

The Canadian Approach to All-Weather Interceptor Development. J. C. Floyd. *(14th Brit. Commonwealth Lecture, London, Oct. 9, 1958.) RAeS J.*, Dec., 1958, pp. 845–866. Discussion of design development, structural and aerodynamic characteristics, systems, and power plants of the Avro CF-105.

Canadair CL-44. *Flight*, Dec. 12, 1958, pp. 913–916, cutaway drawing. Design, structural, and performance characteristics of a Canadian version of the Britannia, powered by the Rolls-Royce Tyne.

Dornbergers Projektstudier av Raketdrivna Trafikflygplan. Olle Ljungström. *Astronautik*, No. 1, 1958, pp. 37–44. In Swedish. Brief account of a project suggesting a liquid-rocket-driven airliner intended for regular intercontinental passenger transport service over ranges of 2,200 to 6,000 miles at extremely high supersonic speeds.

The Practical Calculation of the Load Distribution on Aircraft. Giuseppe Schepisi. *(NATO AGARD 5th Structures & Materials Panel, Copenhagen, Apr. 29-May 3, 1957.) NATO AGARD Rep. 110*, May, 1957. 21 pp. 11 refs. Derivation of the mass forces in terms of the rigid and elastic degrees of freedom of aircraft motion. The equations are solved for prescribed steady flight conditions in a symmetrical case with the aid of the component aerodynamic distribution which can be obtained separately by aerodynamic theory.

Ejection Seats

Some Fundamental Considerations in the Selection and Design of Escape Capsules. D. M. Root. *SAE Natl. Aero. Meeting, Los Angeles, Sept. 29-Oct. 4, 1958, Preprint 91D.* 16 pp. Discussion in terms of escape system characteristics associated with escape survival and of those associated with the effect of the escape unit on the weapon system.

Escape Systems: A Methodology to Meet the Needs. A. I. Beck and George Hildebrand. *SAE Natl. Aero. Meeting, Los Angeles, Sept. 29-Oct. 4, 1958, Preprint 91C.* 13 pp. Discussion on the development, design, production, and evaluation of successful escape systems.

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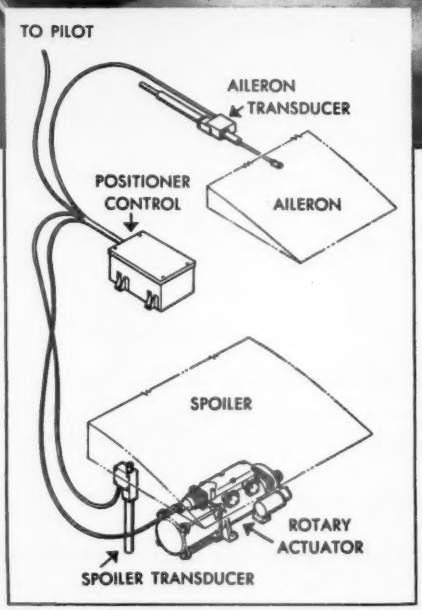

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PUBLISHED MONTHLY BY AERO/SPACE ENGINEERING

Official Publication of the Institute of the Aeronautical Sciences, 2 East 64th Street, New York 21, N.Y.

Volume 4, Number 3 March, 1959

ACOUSTICS, SOUND, NOISE

PROPAGATION OF WEAK DISTURBANCES IN A GAS SUBJECT TO RELAXATION EFFECTS. F. K. Moore and W. E. Gibson. IAS 27th Annual Meeting, New York, Jan. 26-29, 1959, Rep. 59-64. 23 pp. 14 refs. Members, $0.50; nonmembers, $1.00. (Also in Cornell Aero. Lab. Rep. HF-1056-A-2, Dec., 1958.) AFOSR-supported derivation of a generalized wave equation for sound disturbances in a gas when relaxation connected with molecular vibration or dissociation are important. Solutions involving discontinuous wave fronts are presented, and it is shown that, under certain assumptions, the complete wave equation reduces to a variant of the telegraph equation. Detailed solutions are presented for disturbance fields produced by a wavy wall in subsonic and supersonic flow, and a simple wedge in supersonic flow. The connection between the present theory and the theory of dispersing nonlinear waves is briefly considered.

PRELIMINARY MEASUREMENTS OF THE NOISE CHARACTERISTICS OF SOME JET-AUGMENTED-FLAP CONFIGURATIONS. D. J. Maglieri and H. H. Hubbard. US, NASA Memo. 12-4-58L, Jan., 1959. 23 pp. Presentation of some far-field noise characteristics in the form of noise radiation patterns and frequency spectra. The effect of changing nozzle geometry, flap length, flap deflection, as well as changes in the jet-mixing patterns, are given, along with some possible implications of the data.

A NOTE ON THE PRESSURE DISTURBANCE AT GROUND LEVEL CAUSED BY HIGH-FLYING SUPERSONIC AIRCRAFT. N. C. Freeman and S. H. Lam. Princeton U. Dept. Aero. Eng. Rep. 444 (AFOSR TN 58-1127) [AD 207781], Dec., 1958. 11 pp. Assessment of the effect of nonuniformity of the atmosphere in attenuating the waves from the aircraft, and establishment of a relation to some gross parameters of the aircraft. The linear supersonic flow theory is used to compute the pressure disturbance at a large distance from the aircraft and the attenuation of this disturbance through a Rand standard atmosphere by a simple application of Whitham's theory. Formulas for either a "lift-controlled" or a "shape-controlled" bang are given as a function of the gross parameters of the aircraft, such as Mach Number, altitude, size, slenderness ratio, lift coefficient, and certain design factors which depend on detailed knowledge of the aircraft in question.

AERODYNAMICS, FLUID MECHANICS

SOME SIGNIFICANT DEVELOPMENTS IN AERODYNAMICS SINCE 1946. (The First Daniel and Florence Guggenheim Memorial Lecture). Theodore von Kármán. (1st Internatl. Congr. Aero. Sci., Madrid, Sept. 8, 1958.) J. Aero/Space Sci., Mar., 1959, pp. 129-144, 154. 160 refs. Historical review of developments in aerodynamic theory; included in the discussion are such topics as wing theory, slender wings and bodies, interference effects, aeroelastic theories, transonic flow, hypersonic flow, boundary-layer theory, and theory of turbulence.

Aerothermodynamics

HEAT TRANSFER IN SEPARATED FLOWS. H. K. Larson. IAS 27th Annual Meeting, New York, Jan. 26-29, 1959, Rep. 59-37. 13 pp. Members, $0.50; nonmembers, $1.00. Presentation of results of an experimental heat-transfer investigation in separated flow regions, and comparison with a theoretical analysis. The measurements covered Mach Numbers from 0.3 to 4.0 and Reynolds Numbers from 10^5 to 4×10^6. The average heat transfer for both laminar and turbulent separated boundary layers was found to be from 35% to 50% less than that for equivalent attached boundary layers. The results for laminar boundary layers agree well with the analysis, but those for turbulent boundary layers disagree considerably. Results of velocity and temperature surveys in the separated turbulent boundary layer are presented and partially explain the discrepancy between experiments and analysis. The maximum local heat-transfer rates are found to occur in the reattachment region of the separated boundary layers.

The effect of transition on heat transfer in the separated laminar boundary layers is described.

HEAT CONDUCTION IN SOLIDS AT HYPERSONIC SPEED. Luigi Broglio. (NATO AGARD Meeting, Copenhagen, Oct., 1958.) Roma U. Sch. Aero. Eng. Inst. Aero. Construc. Rep. SIAR 30 (AFOSR TN 58-1132) [AD 207977], Oct., 1958. 33 pp. Extension of a formula giving the temperatures in a body of arbitrary shape due to an instantaneous heat source to the case of a body whose thermal properties are dependent upon temperature. By using this solution and expressing at each instant both the space distribution of temperature and heat flow by means of an infinite series, a simple formula is obtained which relates directly each series coefficient of the temperature to the corresponding series coefficient of the heat flow. In the problem considered the surface heat flows are highly dependent upon the trajectory of the body in the atmosphere. An exact expression is found for such a trajectory in the case where gravity and centrifugal forces can be neglected. Calculations are made for copper and stainless steel hemispheres, and results are presented graphically.

SUBLIMATION IN A HYPERSONIC ENVIRONMENT. S. M. Scala. G-E MOSD TIS R58SD289, Oct. 9, 1958. 45 pp. 12 refs. USAF-sponsored analysis of the processes of diffusion, convection, and thermal exchange during sublimation by performing a mass and energy balance at the interface of a vaporizing material. It is first shown that although the solution, which is double-valued, appears to be indeterminate, sufficient constraint exists to determine a unique solution. The mass transfer rate and surface temperature are obtained as a function of the gasification ratio, Γ. For the hypothetical refractory oxide material considered, the total mass loss from the surface is low, decreasing as Γ approaches unity (pure sublimation). In addition, the effects of stagnation enthalpy and stagnation pressure are investigated.

EFFECTIVENESS OF RADIATION AS A STRUCTURAL COOLING TECHNIQUE FOR HYPERSONIC VEHICLES. R. A. Anderson and W. A. Brooks, Jr. IAS 27th Annual Meeting, New York, Jan. 26-29, 1959, Rep. 59-65. 18 pp. Members, $0.50; nonmembers, $1.00. Analysis of the more significant effects of internal heat transfer within idealized structures, both with and without external insulation on areas of greatest aerodynamic heating intensity. Selective use of insulation leads to structural temperature reductions substantially greater than those obtained without insulation. The results are presented in nondimensional form, and numerical examples illustrate applications to hypersonic flight vehicles.

THE EXPERIMENTAL EXAMINATION OF THE LOCAL HEAT TRANSFER ON THE SURFACE OF A SPHERE WHEN SUBJECTED TO FORCED CONVECTIVE COOLING. J. Wadsworth. Canada, NRC Div. Mech. Eng. Rep. MT-39, Sept. 12, 1958. 64 pp. Measurement of heat-transfer distribution over a range of Reynolds Numbers from 20,000 to 240,000, based on sphere diameter. Comparison is made with other work and the discrepancies noted between the sets of results have been partially explained as a difference of turbulence level in the respective flow facilities. Further effects which could contribute to the discrepancies were the use of different blockage ratios incurred by the spheres in their respective flow facilities, and the use of different methods of mounting and presenting spheres to the airflow. The disturbing effect of the sting, supporting the sphere, on the flow close to the sphere and hence on the heat transfer pattern has also been noted.

EFFECT OF INJECTION OF FOREIGN GASES ON THE SKIN FRICTION AND HEAT TRANSFER OF THE TURBULENT BOUNDARY LAYER. C. C. Pappas. IAS 27th Annual Meeting, New York, Jan. 26-29, 1959, Rep. 59-78. 7 pp. Members, $0.50; nonmembers, $1.00. Study to determine the quantitative effect of foreign gas injection on the total skin friction of the turbulent boundary layer and to ascertain the effectiveness of gas injection on the reduction of heat transfer from the boundary layer. The foreign injection gases considered are helium, air, and Freon-12 (CCl_2F_2). The results are for a Reynolds Number of ten million and it is apparent that the light gases, hydrogen and helium, show marked reductions on the skin friction as compared with air injection for equivalent mass flows. The heavy gas Freon-12 shows less reduction than does air injection. Reductions in skin friction of 80% are shown for air-injection rates of the order of 0.003 of the main stream flow. Similar reductions in heat transfer are shown.

FREE-FLIGHT INVESTIGATION OF A ROCKET-PROPELLED MODEL TO DETERMINE THE AERODYNAMIC HEATING ON A THIN, UNSWEPT, UNTAPERED, MULTISPAR, ALUMINUM-ALLOY WING AT MACH NUMBERS UP TO 2.22. Appendix - CALCULATIONS OF TEMPERATURES FOR INTERNAL WING STRUCTURES. E. W. Stephens. US, NASA Memo. 12-15-58L, Jan., 1959. 38 pp. Presentation of temperature-time measurements made on a wing in free flight up to Mach 2.22 and a corresponding Reynolds Number per foot of 13.2×10^6. The experimental installation and technique are described, and results discussed. Reasonably good agreement exists between Stanton Numbers obtained from measured temperature-time data and values obtained by the theory of Van Driest for flat plates having turbulent boundary layers. Temperature measurements made in the skin of the wing and in the internal structures agree well with calculated values.

Boundary Layer

PRIBLIZHENNYI METOD RASCHETA NESTATSIONARNOGO TURBULENTNOGO POGRANICHNOGO SLOIA V NESZHIMAEMOI ZHIDKOSTI. L. A. Rozin. Prikl. Mat. i Mekh., Nov.-Dec., 1958, pp. 842-847. In Russian. Development of an approximate method for calculating the unsteady turbulent boundary layer, based on the analogy between laminar and turbulent unsteady layers.

Several illustrative examples leading to certain qualitative results are presented.

CIRCULATION CONTROL RESEARCH; WIND-TUNNEL TESTS OF A POWERED, BLOWING-TYPE, CIRCULATION CONTROL RESEARCH AIRPLANE MODEL. VI - SUMMARY REPORT. R. K. Wattson, Jr. U. Wichita, Dept. Eng. Res. Rep. 187-6, Feb., 1958. 74 pp. 12 refs. ONR-supported investigation of the effects of circulation control on the contribution of thrust to wing lift and drag, and on the effectiveness of the movable control surface. The behavior of the flow field about the model is portrayed using surface tufts, a tuft grid, and a multi-tube survey rake for ascertaining downwash velocities and angles at the tail location. A brief interpretative analysis, applied to hypothetical aircraft of fixed size and varying wing and power loadings, is presented.

BOUNDARY LAYER TRANSITION ON BLUNT BODIES WITH HIGHLY COOLED BOUNDARY LAYERS. K. F. Stetson. IAS 27th Annual Meeting, New York, Jan. 26-29, 1959, Rep. 59-36. 19 pp. 19 refs. Members, $0.50; nonmembers, $1.00. USAF-sponsored investigation of boundary layer transition in shock tube experiments on hemisphere-cylinder and ellipse-cylinder configurations under conditions of extreme boundary layer cooling. Transition Reynolds Number distribution curves are obtained at several stagnation-to-wall enthalpy ratios. The shock tube experiments indicate that a characteristic feature of transition for a highly cooled boundary layer on a hemisphere is the simultaneous occurrence of transition over the entire supersonic portion of the hemisphere. This implies that transition first occurred in the sonic region. The transition Reynolds Number in the sonic region increased from about 225 to 325 as the stagnation-to-wall enthalpy ratio increased from about 9 to 30. The results further indicate that boundary layer cooling is not a critical transition parameter for blunt bodies. The boundary layer history (body shape history) appears to be an important parameter affecting the magnitude of the Reynolds Number for the case of transition with increased boundary layer cooling.

ÜBER DEN EINFLUSS DES GLEITENS BEI VERDÜNNTEN GASEN AUF DIE ENTSTEHUNG DER TAYLOR-GÖRTLER-WIRBEL. K. Kirchgässner. DVL Bericht No. 75, Nov., 1958. 29 pp. 20 refs. Westdeutscher Verlag, Köln & Opladen. In German. Study of the stability of a laminar boundary layer flow along a concave wall in moderately rarefied gases in order to determine the effect of slip on the development of Taylor-Görtler vortices. The study leads to a problem in which the eigenvalue contains as its essential part the Reynolds Number. The perturbation method is used to determine the critical eigenvalue necessary for the transition, and it is shown that the instability increases with increasing rarefaction of gases.

INVESTIGATION OF THE INTERACTION OF A TURBULENT BOUNDARY LAYER WITH PRANDTL-MEYER EXPANSION FANS AT M = 1.88. K. R. A. Murthy and A. G. Hammitt. Princeton U. Dept. Aero. Eng. Rep. 434 (AFOSR TN 58-839) [AD 203081], Aug., 1958. 34 pp. Experimental study of the interaction problem. Static pressure and total head tube measurements are made, and schlieren photographs of the flow pattern over various expansion wedges are presented. The method of rotational characteristics is applied to the boundary-layer velocity distribution as it expands around the corner to construct the flow field and to calculate the inviscid pressure distribution near the corner. An analytic interpretation of results is made. It is shown that the turning of the supersonic flow around a sharp corner causes the flow to accelerate, giving rise to a lower static pressure. In the presence of a boundary layer, the flow field does not agree with the classical flow near the corner, but it approximates Prandtl-Meyer flow some distance downstream from the corner. Total head surveys made for the 25° expansion case indicate that a high shear layer exists near the wall.

PRESSURE FLUCTUATIONS ON THE WALL ADJACENT TO A TURBULENT BOUNDARY LAYER. Mark Harrison. US, Navy Dept., David Taylor Model Basin, Rep. 1260, Dec., 1958. 13 pp. Study of a fully developed turbulent boundary layer with a zero pressure gradient in a subsonic wind tunnel. The pressure fluctuations on the wall of the wind tunnel were measured by small flush-mounted microphones. Data for the dimensionless spectral density of the pressure fluctuations are presented as a function of the frequency parameter. The transverse cross correlation for the pressure fluctuations and the longitudinal cross spectral density were studied.

THE PREDICTION OF SEPARATION OF THE TURBULENT BOUNDARY LAYER. B. S. Stratford. J. Fluid Mech., Jan., 1959, pp. 1-16. 19 refs. Presentation of a rapid method for the prediction of flow separation results from an approximate solution of the equations of motion. The equations are integrated by a modified "inner and outer solutions" technique developed for laminar boundary layers, the criterion for separation being obtained as a simple formula applying directly to the separation position. The prediction of the pressure rise to separation is likely to be from 0 to 10% too low, which makes it less accurate than Maskell's method which utilizes the Ludweig-Tillmann skin friction law. The main derivation is for arbitrary pressure distributions, while an extension leads to the pressure distribution which first maintains zero skin friction throughout the region of pressure rise. The concept of a turbulent inner layer with zero wall stress is proposed, and it is deduced that, in the neighborhood of the wall, the velocity is proportional to the square root of the distance from the wall.

Flow of Fluids

AN EXPERIMENTAL FLOW WITH ZERO SKIN FRICTION THROUGHOUT ITS REGION OF PRESSURE RISE. B.S. Stratford. J. Fluid Mech., Jan.,

1959, pp. 17-35. 11 refs. Presentation of test results for a flow having effective zero skin friction throughout its region of pressure rise which extends for a distance of three feet. The dynamic head in the zero skin friction boundary layer was found to be linear at the wall, as predicted theoretically in a previous study. The flow appears to achieve any specified pressure rise in the shortest possible distance and with probably the least possible dissipation of energy for a given initial boundary layer. A design pressure distribution should have a slightly more gradual start to the pressure rise than in the present experiment, as small errors close to the discontinuity can cause difficulty.

EXPERIMENTAL SEARCH FOR THE EFFECT OF COMPRESSIBILITY IN UNSTEADY COUETTE FLOW. Leslie Hromas and Harold DeGroff. J. Fluid Mech., Jan., 1959, pp. 140-150. Consideration of the compressible Rayleigh problem involving an impulsively moving flat plate, which indicates that transverse velocities can be generated by a purely longitudinal shearing motion. To demonstrate the existence of such transverse velocities, an experiment was conducted using concentric rotating cylinders to generate the flow. Since these transverse velocities were too small to be measured directly, a temperature gradient was created across the annulus to take advantage of the much greater sensitivity of a hot-wire to temperature fluctuations produced by the fluctuation in the transverse velocity. The periodic temperature fluctuations noted were converted to equivalent transverse velocities. Experimental values obtained agreed qualitatively with the theory.

AN EXPLORATORY STUDY AT M = 14 OF THE FLOW ABOUT A HEMISPHERE CYLINDER AT ANGLE OF ATTACK. I. E. Vas and S. M. Bogdonoff. Princeton U. Dept. Aero. Eng. Rep. 438 (USAF WADC TN 58-331) [AD 205461], Sept., 1958. 22 pp. Investigation of flow over a hemisphere cylinder at angles of attack up to 9°. From the optical study, the shock shape near the nose was found unaffected by the angle of attack of the body. The pressures on the hemispherical nose section can be predicted by the Newtonian pressure corrected for losses across the shock. The pressures on the cylindrical portion, however, are not predicted by this method. A linearized technique based on the extrapolation of the pressure distribution at zero angle of attack gives an approximate value to the measured pressures at angle of attack.

INVESTIGATION OF NORMAL FORCE DISTRIBUTIONS AND WAKE VORTEX CHARACTERISTICS OF BODIES OF REVOLUTION AT SUPERSONIC SPEEDS. J. F. Mello. J. Aero/Space Sci., Mar., 1959, pp. 155-168. 10 refs. Navy-supported experimental study of the aerodynamic characteristics of an inclined body of revolution and assessment of the adequacy of available methods for estimating these characteristics. A 30° cone-cylinder has been used to obtain normal force and pitching moment data, normal force distributions, and local flow properties. Comparisons of experimental and theoretical results are presented for a wide variety of conditions for which experimental data were obtained.

NELINEINYE KONICHESKIE TECHENIIA GAZA. B. M. Bulakh. Prikl. Mat. i Mekh., Nov.-Dec., 1958, pp. 781-788. In Russian. Evaluation of previously derived theories and development of a method for obtaining the second approximation in the theory of nonlinearized, nonvortical, steady conical gas flows. The case of an axisymmetrical flow around a cone is used as an example to verify the accuracy of the method.

THE EFFECT OF LEADING-EDGE SWEEP AND SURFACE INCLINATION ON THE HYPERSONIC FLOW FIELD OVER A BLUNT FLAT PLATE. M. O. Creager. US, NASA Memo. 12-26-58A, Jan., 1959. 45 pp. 18 refs. Investigation of flow over flat blunt plates at Mach Numbers of 4 and 5.7 with sweep angles from 0° to 60°, a range of surface inclinations from -10° to +10°, and free-stream Reynolds Numbers per inch of 6,600 and 20,000, respectively. The surface pressures were predicted within an average error of ±8% by a combination of blast-wave and boundary-layer theory extended to include effects of sweep and surface inclination. The local Reynolds Number per inch was found to be lower than the free-stream Reynolds Number per inch. The reduction in local Reynolds Number is mitigated by increasing the sweep of the leading edge. Boundary-layer thickness and shock-wave shape were little changed by the sweep of the leading edge.

VISCOUS AERODYNAMIC CHARACTERISTICS IN HYPERSONIC RAREFIED GAS FLOW. Appendix A - NAVIER-STOKES EQUATIONS IN POLAR COORDINATES. Appendix B - SHOCK WAVE CONSERVATION EQUATIONS. R. F. Probstein and N. H. Kemp. IAS 27th Annual Meeting, New York, Jan. 26-29, 1959, Rep. 59-62. 25 pp. 21 refs. Members, $0.50; nonmembers, $1.00. USAF-supported presentation of an order-of-magnitude analysis to define the regimes of rarefied gas flow and the limits of continuum theory. On the basis of theoretical and experimental evidence it is suggested that, except "very close" to the free molecule condition (first-order collision regime), the Navier-Stokes equations (but not the boundary layer equations) may be used as a model. Excluding the first-order collision regime, it is shown that in the intermediate regime there are two fundamental classes of problems: a viscous layer class and a merged layer class, the latter corresponding to a larger degree of rarefaction. For a sphere and a cylinder it is shown that new exact solutions of the Navier-Stokes equations can be obtained for both the viscous and the merged layer classes of problems. These calculations are applied to the evaluation of surface shear, heat transfer rate, and other aerodynamic characteristics of a sphere and cylinder flying at satellite velocity under rarefied gas conditions corresponding to the intermediate regime.

VISCOUS HYPERSONIC SIMILITUDE. W. D. Hayes and R. F. Probstein. IAS 27th Annual Meeting, New York, Jan. 26-29, 1959, Rep. 59-63. 23

pp. Members, $0.50; nonmembers, $1.00. AFOSR-supported development of an extension of classical hypersonic similitude which takes into account the interaction effect of the displacement thickness of the boundary layer. A basic result of this viscous similitude is that the total drag including friction drag obeys the classical similarity law for the pressure drag. Underlying the similitude is a new hypersonic boundary layer independence principle. According to this, the principal part of a hypersonic boundary layer with given pressure and wall temperature distributions and free stream enthalpy is independent of the (high) external Mach Number distribution outside the boundary layer. Various features of viscous hypersonic similitudes are discussed. It is found that it applies to three-dimensional boundary layer interaction effects on flat bodies, provided the concepts of strip theory may be applied, and provided the aspect ratio is an invariant.

HYPERSONIC VISCOUS FLOW PAST A BLUNT BODY WITH AN APPLIED MAGNETIC FIELD. I. Ching-Sheng Wu. Princeton U. Dept. Aero. Eng. Rep. 443 (AFOSR TN 58-1125) [AD 207834], Nov., 1958. 26 pp. Analysis showing that local similarity solutions of flow field and temperature distribution are obtainable if both hydromagnetic interaction and viscous effect are taken into account. Various simplifying assumptions are made. The similarity solutions for the two-dimensional problem are presented, and the boundary conditions associated with different physical problems are discussed. Boundary conditions and similarity solutions for the stagnation point flow behind a detached shock wave with spherical shape are investigated. The temperature distribution and the pressure variation in the shock layer near the stagnation point region are studied.

EFFECTS OF GRAVITATIONAL OR ELECTROMAGNETIC FIELDS ON FLUID MOTION. Chia-Shun Yih. Quart. Appl. Math., Jan., 1959, pp. 409-415. Analysis indicating that the effect of gravity on a stratified fluid is to inhibit steady motion in the direction of gravity; that, for small values of the magnetic viscosity, the effect of a main magnetic field is to make steady weak motions of a fluid independent of the distance along the lines of force; and that, again for small values of the magnetic viscosity, the effect of a uniform electric field is to make steady weak motions of a fluid rotationally symmetric with respect to an axis in the direction of the fluid field. These results, together with those of Proudman for a rotating fluid, show that the effects of rotation, gravity, and electromagnetic fields are to endow the fluid with anisotropic rigidity by "stiffening" it along the vorticity lines, the isopycnic surfaces or lines, or the lines of force, as the case may be.

RAYLEIGH'S PROBLEM IN HYDROMAGNETICS: IMPULSIVE MOTION OF A POLE-PIECE. G. S. S. Ludford. U. Md. Inst. Fluid Dynamics & Appl. Math. TN BN-151 (AFOSR TN 58-1073) [AD 207242], Nov., 1958. 22 pp. Analysis of the motion of an incompressible, viscous, electrically conducting fluid contained between the parallel, plane pole-pieces of a permanent magnet which provides a uniform external field in the y-direction. Starting at time $t = 0$, with the fluid at rest, the magnet is made to move uniformly in the negative x-direction. A simple exact solution is presented for which the transition from zero to infinite conductivity is traced and the modifying effects of viscosity determined.

ENERGY DIFFUSION OF FAST IONS IN AN EQUILIBRIUM PLASMA. V. S. Kudriavtsev. (Zhurnal Teoret. i Exper. Fiz., June, 1958, pp. 1, 558-1, 565.) Sov. Phys. - JETP, Dec., 1958, pp. 1, 075-1, 079. Translation. Analysis considering the energy distribution of the injected ions as initially monochromatic, with the energy exceeding the mean thermal energy in the plasma. It is assumed in this case that the distribution of velocity directions is isotropic. The extent to which the distribution approaches a Maxwellian one is determined. For an arbitrary initial distribution, the result can be obtained by the principle of superposition, since the equations are linear.

GENERATION OF SUPERSONIC DISSOCIATED AND IONIZED NON-EQUILIBRIUM STREAMS. D. E. Rosner and H. F. Calcote. AeroChem Res. Lab. TM 10 (AFOSR TN 58-1080) [AD 207590], Oct., 1958. 30 pp. 10 refs. Development of a small-scale research tool producing a steady-state, supersonic, nonequilibrium stream of atoms and ions. Fully expanded streams of air, nitrogen, argon, and helium, at Mach Numbers from 2 to 4, are studied. Preliminary measurements indicate that roughly 50% of the energy input is utilized in dissociating and ionizing the gas, while the overall efficiency of the device is about 80%. Estimates of the resulting degree of dissociation and ionization are made. An estimate of the magnetic field strength necessary to produce easily measurable magnetogasdynamic effects on aerodynamic heat-transfer rates is also included.

SIMPLE VORTICITY LAWS IN MAGNETOHYDRODYNAMICS. Ching-Sheng Wu. Princeton U. Dept. Aero. Eng. Rep. 445 (AFOSR TN 58-1044) [AD 206756], Nov., 1958. 16 pp. Derivation of simple vorticity laws in magnetohydrodynamics. The analysis includes the generalized Crocco's vorticity law and Lighthill's expression for vorticity behind a three-dimensional shock wave. No consideration is given to microscopic phenomena of an ionized gas. A generalization of Hayes derivation of vorticity jump across a gas dynamic discontinuity is also obtained.

A CLASS OF EXACT SOLUTIONS OF THE MAGNETOHYDRODYNAMIC NAVIER-STOKES EQUATIONS. Ching-Sheng Wu. Princeton U. Dept. Aero. Eng. Rep. 436 (AFOSR TN 58-895) [AD 204134], Sept., 1958. 51 pp. Derivation of a class of similarity solutions for the magnetohydrodynamic Navier-Stokes equations in order that the original differential system may be reduced to two ordinary differential equations. The equation governing the velocity field appears to be of first

order but having a nonlinear interaction term in the magnetic field. The magnetic induction equation, however, is of second order. Solutions similar to those obtained by Landau and Squire for the nonmagnetic case are found by using a perturbation expansion of small ratio $\propto$ (kinematic viscosity/magnetic viscosity).

OBLIQUE SHOCK WAVES IN A PLASMA WITH FINITE CONDUCTIVITY. M. I. Kiselev and V. I. Tsepliaev. (Zhurnal Teoret. i Exper. Fiz., June, 1958, pp. 1,605-1,607.) Sov. Phys. - JETP, Dec., 1958, pp. 1,104-1,106. Translation. Study of the structure in the front of an oblique shock wave for an arbitrary orientation of the field ahead of the front in a plasma with finite conductivity. The plasma is considered to have a constant and isotropic conductivity sufficiently large not to have to take displacement current into account, and the effects of viscosity and thermal conductivity are neglected. An estimate on the width of the wave front is given, and the limiting angle for the propagation of an oblique shock wave is obtained.

ELECTRO-GASDYNAMIC MOTION OF A CHARGED BODY IN A PLASMA. L. Kraus and H. Yoshihara. IAS 27th Annual Meeting, New York, Jan. 26-29, 1959, Rep. 59-75. 10 pp. Members, $0.50; nonmembers, $1.00. Analysis of some aspects of the coupling between fluid motion and the electrostatic properties of a plasma. The basic equations are described and the theory illustrated by treating the very simple case of supersonic flow of a plasma past a two-dimensional slender dielectric body. A simplification requires that the "boundary layer" be absent. Here, "boundary layers" are defined as narrow regions in which the electrostatic potential and the flow properties change rapidly. The precise analysis of the effects would require the use of the complete fourth-order system of differential equations. These equations are twofold hyperbolic and twofold elliptic when the motion of the body is supersonic with respect to the ion thermal velocity. This property manifests itself by an upstream effect ahead of the leading edge Mach wave which dampens exponentially. Electrical effects instead of influencing the entire medium are confined essentially to a region downstream of an electrostatic Mach envelope.

IGNITION OF A THERMONUCLEAR PLASMA BY HIGH-ENERGY INJECTION. Albert Simon. Phys. Fluids, Nov.-Dec., 1958, pp. 495-500. Study of the effect of a neutral gas background on the formation of a thermonuclear plasma by high-energy injection. Three ways of overcoming this barrier are described. The first is by sufficiently reducing the initial gas pressure; the second by injecting sufficient current so that plasma self-shielding or burnout occurs; and the third by use of the ion pumping or "gettering" action of the trapped plasma.

ACCELERATED SELF-CONSTRICTED ELECTRON STREAMS IN PLASMA. J. G. Linhart. Royal Soc. (London) Proc., Ser. A, Jan. 13, 1959, pp. 318-334. 14 refs. Analysis considering the mechanism of radial oscillations in a neutralized cylindrical electron stream of an accelerating electric field. The method is based on the two-fluid model of plasma. Analytical expressions for amplitude oscillations and numerical solutions for large amplitudes are derived. When electron-positive ion collisions are taken into account, it is found that for dense streams in low electric fields the radial oscillations (pinch oscillations) can destroy the streaming character of the electron flow and thus prevent its acceleration.

INVERSE PINCH EFFECT. O. A. Anderson, H. P. Furth, J. M. Stone, and R. E. Wright. Phys. Fluids, Nov.-Dec., 1958, pp. 489-494. Description of a device in which the usual conducting cylinder is replaced by an axial rod surrounded by the ionized gas. When the current passes through the gas and returns along the rod, the magnetic field pushes the plasma outward, leaving a cylindrical vacuum region behind. Except at the highest gas densities, the velocity is in good agreement with the "snow plow" theory of Rosenbluth, and the thickness of the front is reasonably consistent with the "snow plow" model.

PLASMA MOTIONS INDUCED BY SATELLITES IN THE IONOSPHERE. Appendix - DAMPING WHEN THE DENSITY IS HIGH. Lester Kraus and K. M. Watson. Phys. Fluids, Nov.-Dec., 1958, pp. 480-488. 12 refs. Analysis of the electrohydrodynamic phenomena associated with the high-velocity motion of a charged body in a plasma. It is shown that the effect of the electric field due to the charge on the body in inducing collective motion leads to similar results both for high- and low-density gases. By using a linearized theory, formulas are obtained for the electrohydrodynamic drag and for the increased ionization in the Mach cone behind the body.

TWO SOLUTIONS FOR INVISCID ROTATIONAL FLOW WITH CORNER EDDIES. Chia-Shun Yih. J. Fluid Mech., Jan., 1959, pp. 36-40. Analysis of steady rotational flow of an inviscid fluid in a two-dimensional channel or a circular tube toward a sink. The velocity distribution at infinity is approximated by a cosine curve for the two-dimensional case, and is taken as exactly parabolic for the axisymmetric case. The dependence of vorticity on the stream function is assumed to be everywhere the same as it is for streamlines coming from infinity upstream. The resulting linear equations of motion are solved exactly. The solutions show the rather unusual features of separating streamlines and regions of closed flow (corner eddies).

STRUCTURE OF WEAK SHOCK WAVES IN A MONATOMIC GAS. Appendix A - FREE-MOLECULE-PROBE HEAT LOSSES. Appendix B - INTEGRATION OF BURNETT EQUATIONS. L. Talbot and F. S. Sherman. US, NASA Memo. 12-14-58W, Jan., 1959. 51 pp. 23 refs. Experimental determination of the profiles and thicknesses of normal shock waves in argon at Mach Numbers from 1.335 to 1.713, using a free-molecule probe

whose equilibrium temperature is related by kinetic theory to the local flow properties and their gradients. Comparisons were made between the experimental shock profiles and the theoretical profiles calculated from the Navier-Stokes equations, the Grad 13-moment equations, and the Burnett equations. The experimental shock profiles were predicted with approximately equal success by the Navier-Stokes and Burnett theories, while the 13-moment method was definitely less satisfactory.

SOME INTEGRATED PROPERTIES OF SOLUTIONS OF THE WAVE EQUATION WITH NON-PLANAR BOUNDARIES. Lu Ting. Quart. Appl. Math., Jan., 1959, pp. 373-384. 14 refs. Analysis of supersonic flow outside a cylindrical surface with generators parallel to the flow direction, in which a theorem is proved concerning the integrated properties of the linearized pressure distribution and the prescribed normal velocity on the surface. The theorem is a generalization of the integral relationships obtained previously, and is useful in the evaluation of total lift and drag of wing-body combinations when the linear dimensions of the cross section of the body are not small as compared to the chord length. For the diffraction of a pulse or a weak shock over a rectangular notch, a pressure integral theorem is obtained. Its usefulness is demonstrated in reducing the labor of obtaining the mean pressure distribution along any depth inside the notch at different instants for various width-height ratios of the notch.

ON CURVED SHOCK WAVES IN THREE-DIMENSIONAL GAS FLOWS. R. P. Kanwal. Quart. Appl. Math., Jan., 1959, pp. 361-372. 12 refs. Derivation of formulas for the determination of the gradients of velocity components, pressure, density, and entropy behind the shock surface when the flow in front is known. The required derivatives are obtained by differentiating the Rankine-Hugoniot relations along the shock surface. The flow behind the shock wave is found in general to be rotational. The explicit determination of the vorticity components is carried out. This leads to the formulation of a theorem regarding the characterization of surfaces behind which the flow remains irrotational. It is found that the plane, the right circular cone, the cylinder, and the developable helicoid are the only such surfaces. Furthermore, it is found that the component of vorticity along the normal to the shock surface vanishes at every point of the surface; a property shared by the contact discontinuities which are surfaces across which the normal component of the velocity is continuous while the tangential components are discontinuous.

THE EFFECT OF WALL SHAPE ON THE DEGREE OF REINFORCEMENT OF A SHOCK WAVE MOVING INTO A CONVERGING CHANNEL. G. A. Bird. J. Fluid Mech., Jan., 1959, pp. 60-66. Application of the one-dimensional theory for the interaction between a normal shock wave and a discontinuous reduction in area to the problem of flow in a two-dimensional channel. It is shown that, for a given overall area ratio, a channel shape consisting of two equal discontinuous reductions in area produces a larger gain in shock strength than a channel having a single discontinuity. The gain in shock strength continues to increase with the number of steps, until the ideal limiting case of an infinite number of vanishingly small changes in area is reached. A drum camera is used to measure, in a shock tube, the increase in speed of normal shock waves passing through two-dimensional converging channels of different wall shape. It is found that a single discontinuous change produced a gain in shock strength which was less than half that given by the one-dimensional analysis.

THE STRUCTURE OF A CONTACT REGION, WITH APPLICATION TO THE REFLEXION OF A SHOCK FROM A HEAT-CONDUCTING WALL. F. A. Goldsworthy. J. Fluid Mech., Jan., 1959, pp. 164-176. Study using boundary layer methods to show the pressure across a contact region as being approximately constant. A partial differential equation for the temperature is then derived. The general theory is also used to determine the motion of a plane shock which is reflected from a plane conducting wall. Expressions for temperature, velocity, and pressure at the inlet are derived, and it is shown that the effect of heat conduction is to decrease the velocity of the reflected shock by an amount which varies as the inverse square root of time.

ENTROPY CHANGE DURING RELAXATION OF A GAS BEHIND A SHOCK WAVE. P. Lun'kin. (Zhurnal Teoret. i Exper. Fiz., June, 1958, pp. 1, 526-1, 530.) Sov. Phys. - JETP, Dec., 1958, pp. 1, 053-1, 055. Translation. Investigation of entropy changes which take place as translational, rotational, and vibrational degrees of freedom are successively excited and as dissociation is induced. It is shown that the largest entropy change takes place when the translational degrees of freedom are excited; excitation of other degrees of freedom involves smaller entropy variations.

SMALL-SCALE VARIATION OF CONVECTED QUANTITIES LIKE TEMPERATURE IN TURBULENT FLUID. I - GENERAL DISCUSSION AND THE CASE OF SMALL CONDUCTIVITY. II - THE CASE OF LARGE CONDUCTIVITY. G. K. Batchelor, I. D. Howells, and A. A. Townsend. J. Fluid Mech., Jan., 1959, pp. 113-139. 17 refs. Analysis of a problem proposed when an external agency imposes on a fluid large-scale variations of some dynamically passive scalar quantity θ, such as temperature or concentration of solute, causing the turbulent motion of the fluid to generate small-scale variations of θ. The form of the spectrum of θ at large wave numbers is considered, taking into account the two effects of convection with the fluid and molecular diffusion with diffusivity k.

Internal Flow

EXPERIMENTAL INVESTIGATION OF A THREE-DIMENSIONAL ALL SUPERSONIC DIFFUSING CASCADE. Appendix A - A SUGGESTED "EXACT" SOLUTION TO THREE-DIMENSIONAL

SUPERSONIC FLOWS. T. Iura and E. Beder. Propulsion Prod. Rep. R-288 (AFOSR TR 58-132) [AD 203712], May, 1958. 175 pp. 18 refs. Application of the stream-surface characteristics method to the design of a cascade, and presentation of test results to confirm the design over the Mach Number range from 2.2 to 3.0. Stable supersonic flow is established over a wide range of incidence angles. The type of cascade geometry evolved had high solidities, a low blade thickness ratio, blade profiles with smoothly joined straight wedge sections at the leading edges, and a maximum aspect ratio for minimum weight. From the wind-tunnel tests chordwise blade-surface static pressures, exit-plane pitot surveys, and schlieren photographs are obtained.

PERFORMANCE OF TYPICAL REAR-STAGE AXIAL-FLOW COMPRESSOR ROTOR BLADE ROW AT THREE DIFFERENT BLADE SETTING ANGLES. M. I. Kussoy and Daniel Bachkin. US, NASA Memo. 11-27-58E, Jan., 1959. 37 pp. Comparison of the performance of a rotor run at three setting angles covering a 30° range. The results indicate higher peak pressure ratios and greater maximum equivalent weight flows for the lower setting angles at all speeds tested. During part-speed operation, the efficiencies were higher for the lower setting angles and the flow ranges were about the same for all three setting angles. However, near maximum speed, the flow range is noticeably less for the lowest setting angle while the efficiencies are about the same for each configuration.

ON THE STABILITY OF FULLY DEVELOPED FLOW IN A PIPE. G. M. Corcos and J. R. Sellars. J. Fluid Mech., Jan., 1959, pp. 97-112. 18 refs. Study of the stability of pipe flow in which the classical eigenvalue problem is treated in part by asymptotic methods and leads to an algebraic relation between the eigenvalue c, the disturbance wavelength $2\pi/\alpha$, and the Reynolds Number. Examination of the limiting cases of this relation reveals the existence of two families of characteristic numbers, the value of which tends to unity and to zero as the Reynolds Number increases without bounds. It is found that all eigenvalues yield stable solutions and that for a given wave number and Reynolds Number only a finite number of eigenvalues exists.

AN EXPERIMENTAL INVESTIGATION OF THE STABILITY OF POISEUILLE FLOW. R. J. Leite. J. Fluid Mech., Jan., 1959, pp. 81-96. 11 refs. Test results indicating that within the Reynolds Number range investigated (up to 13,000), the flow is stable for small disturbances. In general, the radial distribution of disturbance is not independent of distance downstream; while the disturbances exhibit the imperfect axial symmetry, the nonsymmetric part decays more rapidly than the symmetric part. Results are interpreted in such a way that rates of propagation and rates of decay of the disturbances could be compared with those given by a recent theoretical stability analysis. It is found that the rates of decay are predicted fairly satisfactorily by the theory; however, the rates of propagation are not.

AN ERROR ANALYSIS OF SOME SPECIAL SUPERSONIC AIR INLET DRAG TESTS. Mats Flaum. SFA L4, Sept., 1957. 25 pp. Calculation of the least accuracy to which the outlet impulse function must be determined in order to obtain the drag D with a certain, presupposed accuracy, assuming that the magnitudes of the errors of any other variables involved in the evaluation of D are known. The general expressions are derived and a numerical example illustrates the application. It is shown that with increasing Mach Number the required accuracy in outlet impulse determination increases rapidly.

INVESTIGATION OF COWL DRAG ON SUPERSONIC AIR INLETS. Gerhard Eklund, Gösta Rosander, and Lars Törnblom. SFA L5, 1957. 35 pp. Investigation of the effect which two cowl shape parameters - lip angle and ratio of intake entry area to maximum area - have on the external drag of an inlet. A number of axisymmetric inlets having no center-body are tested at various flight Mach Numbers and mass flow ratios. The drag is determined experimentally by pressure measurements and theoretically by approximate calculation. A method for calculating the total external drag from the shape of the shock wave is presented and the result compared with experimental and theoretical values.

PRESSURE DRAG OF AXISYMMETRIC COWLS HAVING LARGE INITIAL LIP ANGLES AT MACH NUMBERS FROM 1.90 TO 4.90. N. E. Samanich. US, NASA Memo. 1-10-59E, Jan., 1959. 15 pp. Presentation of the results of experimental and theoretical data on nine cowls to determine the effect of initial lip angle and projected frontal area on the cowl pressure drag coefficient. The experimental drag coefficients approximated well with two-dimensional shock-expansion theory at the lower cowl-projected areas, but the difference between theory and experiment increased as the cowl area ratio was increased or as shock detachment at the cowl lips was approached. An empirical chart, which can be used to estimate the pressure drag coefficient of cowls approaching an elliptic contour, is presented.

AERODYNAMIC THEORY OF THE ANNULAR JET. G. D. Boehler. IAS 27th Annual Meeting, New York, Jan. 26-29, 1959, Rep. 59-77. 15 pp. 23 refs. Members, $0.50; nonmembers, $1.00. ONR-sponsored presentation of a theory to describe the flow mechanics of air jets issuing from annular openings. Two configurations are studied, the first being an annular nozzle far from the ground. The base pressure is calculated theoretically for a two-dimensional viscous laminar or turbulent jet, using a "dividing streamline" concept. A solution of the three-dimensional problem, based on a Mangler transformation, is given. Fair agreement between calculated and experimental base pressures is found. The second configuration

is an annular nozzle close to the ground. The form of the jet and the thrust of the nozzle are described. The variation of the thrust augmentation with the distance from the ground can be explained by simple momentum considerations and good agreement with experimental results is found. Existing experimental data are briefly reviewed and the parameters making their correlation possible pointed out.

ON THE BASE PRESSURE RESULTING FROM THE INTERACTION OF A SUPERSONIC EXTERNAL STREAM WITH A SONIC OR SUBSONIC JET. W. L. Chow. J. Aero/Space Sci., Mar., 1959, pp. 176-180. 12 refs. AFOSR-supported analysis showing that the two-dimensional base pressure problems relating to base bleed into the wake of blunt-trailing-edge airfoils, or the interaction between an external supersonic or sonic slipstream of a jet engine, can be calculated by theoretical considerations. Constant-pressure isoenergetic turbulent mixing between the streams and the stagnant fluid in the wake is assumed. A comparison of theoretical and experimental results shows good agreement.

INTERACTION EFFECTS PRODUCED BY JET EXHAUSTING LATERALLY NEAR BASE OF OGIVE-CYLINDER MODEL IN SUPERSONIC MAIN STREAM. P. W. Vinson, J. L. Amick, and H. P. Liepman. US, NASA Memo. 12-5-58W, Feb., 1959. 37 pp. Theoretical and experimental investigation of interaction effects from a side jet exhausting into supersonic flow. Data are obtained by measuring with a sting balance the normal forces due to a side jet discharging into a supersonic main stream and into a vacuum. Comparison of the two cases gives the interaction force. This force appears to be independent of main-stream Mach Number, boundary-layer condition (laminar or turbulent), angle of attack, and forebody length. The ratio of interaction force to jet force is found to be inversely proportional to the square root of the product of jet stagnation-to-free stream pressure ratio and jet-to-body diameter ratio.

EXPERIMENTS ON POROUS-WALL COOLING AND FLOW SEPARATION CONTROL IN A SUPERSONIC NOZZLE. Leon Green, Jr., and K. L. Nall. IAS 27th Annual Meeting, New York, Jan. 26-29, 1959, Rep. 59-38. 15 pp. 26 refs. Members, $0.50; nonmembers, $1.00. Experimental investigations of flow separation control by spark schlieren photography of dry nitrogen flows expanded from two stagnation temperatures and several stagnation pressure levels. The experimental procedure and results are described. It is shown that flow separation at expansion ratios approaching the optimum value for maximum thrust coefficient can be induced at the porous wall by a local injection mass velocity of the order of a few per cent of the local main-stream mass velocity. Separation at the solid boundary is not noticeably influenced by injection at the opposite wall, and variation of the wall heat-transfer condition has little effect on separation behavior. The effectiveness of the transpiration technique in controlling nozzle wall temperature is demonstrated.

THE BLASIUS EQUATION WITH THREE-POINT BOUNDARY CONDITIONS. L. G. Napolitano. Quart. Appl. Math., Jan., 1959, pp. 397-408. Solutions of the Blasius equation describing the interaction between two parallel streams by a series in terms of ascending powers of the ratio $\lambda = (u_1 - u_2)/u_1$, where u_i is the outer stream velocity. The first three approximations to the Blasius function and to its first two derivatives are also presented in tabulated form with four significant figures. A test on the convergence of the series has been made by comparison with some exact solutions obtained on a high-speed computing machine. The comparison shows that the Blasius function itself is slightly less accurate than its second and first derivatives. Two terms of the series for λ up to 0.5 and three terms for λ up to 0.7 yield extremely accurate results. The errors in the first two derivatives of the Blasius function are always contained within less than one per cent.

Jet Flaps & Wings

BLOWN FLAP SYSTEM FOR STOL PERFORMANCE - WEIGHT CONSIDERATIONS. Milton Schwartzberg. Aero/Space Engrg., Mar., 1959, pp. 48-52, 63. Study of the effect of weight of a blown-flap system installation on the overall aircraft weight and comparison to the weight of an efficient "unblown" high-lift flap installation. The analysis indicates that, for a lower stall speed, the blown flap offers the advantages of a considerably smaller wing and higher cruise speed at no expense in payload capacity. If the take-off and landing distances are to be moderate rather than short, requiring only moderately low stall speeds, a weight analysis may favor the low wing loading method of decreasing stall speed.

LOW-SPEED WIND-TUNNEL INVESTIGATION OF BLOWING BOUNDARY-LAYER CONTROL ON LEADING- AND TRAILING-EDGE FLAPS OF A LARGE-SCALE, LOW-ASPECT-RATIO, 45° SWEPT-WING AIRPLANE CONFIGURATION. R. L. Maki. US, NASA Memo. 1-23-59A, Jan., 1959. 25 pp. Results of tests to determine the effects of leading-edge flap deflection and boundary layer control on maximum lift and longitudinal stability. Leading-edge flap deflection alone was sufficient to maintain static stability without trailing-edge flaps. However, leading-edge flap blowing was required to maintain longitudinal stability by delaying leading-edge flow separation when trailing-edge flaps were deflected either with or without blowing. Partial-span leading-edge flaps deflected 60° with moderate blowing gave the major increase in maximum lift, although higher deflection and additional blowing gave some further increase.

Stability & Control

EFFECTS OF LARGE WING-TIP MASSES ON OSCILLATORY STABILITY OF WING BENDING COUPLED WITH AIRPLANE PITCH. D. T. Higdon. US, NASA Memo. 12-29-58A, Jan., 1959. 32 pp. Analysis showing that instability caused by coupling of airplane pitching and wing bending oc-

curred for large ratios of effective wing-tip mass to total airplane mass and for coupled wing-bending frequencies near or below the uncoupled pitching frequency. Boundaries for this instability are given in terms of two quantities: (a) the ratio of effectives tip mass to airplane mass, and (b) the ratio of the coupled bending frequency to the uncoupled pitch frequency, which can be measured in flight. These boundaries are presented for various values of several airplane parameters.

APPLICATION OF POWER SPECTRAL METHODS IN AIRPLANE AND MISSILE DESIGN. K. R. Thorson and Q. R. Bohne. IAS 27th Annual Meeting, New York, Jan. 26-29, 1959, Rep. 59-42. 23 pp. 13 refs. Members, $0.50; nonmembers, $1.00. Study of power-spectral methods as used in the determination of dynamic loading and response for vehicles subject to continuous turbulence. Input-transfer-function-output relationships are discussed and a procedure is outlined whereby mission design load information may be obtained utilizing high-speed digital computing equipment. Where time rate of change of the atmospheric and aerodynamic characteristics is significant, a continuous analog simulation is suggested. Applications of these techniques to specific problem areas are shown. These include determination of design fin load for a representative high-performance airplane, an evaluation of crew station accelerations for low-level high-speed operation, and missile gust loads in a terminal dive condition.

Wings & Airfoils

ON THE FLOW OF A SONIC STREAM PAST AN AIRFOIL SURFACE. C. S. Sinnott. J. Aero/Space Sci., Mar., 1959, pp. 169-175. 11 refs. Description of the flow pattern and derivation of a semiempirical method for estimating sonic-range pressure distributions. An analysis of the Mach wave pattern indicates that the supersonic domain of the flow can be derived from two simple-wave flows, one arising from the Mach waves reflected at the sonic line and the other from the changes in airfoil surface slope. The compressive effect of the reflected Mach waves is determined quantitatively as a function of airfoil leading-edge geometry from an analysis of measured pressure distributions for uncambered airfoils; and it is shown how this can be superimposed on the wave system from the curved surface to give an equivalent simple-wave flow over the airfoil. An example of the application of the scheme is given and the results agree well with measured values.

PORÓWNAWCZE POMIARY WAGOWE PŁATÓW PIERŚCIENIOWYCH I PROSTOKĄTNYCH O MAŁYCH WYDŁUŻENIACH. Włodzimierz Prosnak. Arch. Budowy Maszyn, No. 3, 1958, pp. 319-333. In Polish, with summaries in English and Russian. Results of tests on five annular and three rectangular airfoils of small aspect ratio, covering weight measurements of lift, drag, and moment for purely subsonic flow velocities and a wide range of angles of attack. Each model was subjected to simulated forward and backward flight conditions. The experimental results are evaluated in terms of the effect of aspect ratio, cone angle β, and the direction of speed of blowing on the aerodynamic properties of annular airfoils.

AERODYNAMIC INFLUENCE COEFFICIENTS FOR DELTA WINGS IN STEADY SUPERSONIC FLOW. D. E. Lees. Aircraft Eng., Jan., 1959, pp. 9-12. Presentation of a numerical method of solving integral equations for flow past delta wings with supersonic and subsonic leading edges. The wing is subdivided into diamond shaped panels by a network of equispaced Mach lines, and the effect of placing unit downwash at each panel in turn is calculated. The resulting influence function, which has been tabulated, is then formed into the required matrix of influence coefficients. An aeroelastic efficiency calculation, for a sonic leading edge 45^0 delta wing of representative torsional stiffness, is included for comparison with strip theory.

CHARACTERISTICS OF SLENDER WING-BODY COMBINATIONS WITH FOLDING WINGS. G. S. Campbell. Aircraft Eng., Jan., 1959, pp. 13-20. Development of a method for calculating aerodynamic loads on slender missiles with complicated cross sections, and application to missiles with folding wings. Comparison with supersonic wind-tunnel measurements indicates that the method should provide satisfactory first estimates of the aerodynamic properties. A series of design charts is presented allowing rapid estimation of lift, folding moment, and span loading for a wide variety of folding-wing configurations.

AEROELASTICITY

TRANSONIC AND SUPERSONIC DIVERGENCE CHARACTERISTICS OF LOW-ASPECT-RATIO WINGS AND CONTROLS. J. Martin and C. E. Watkins. IAS 27th Annual Meeting, New York, Jan. 26-29, 1959, Rep. 59-58. 19 pp. Members, $0.50; nonmembers, $1.00. Analysis of static aeroelastic divergence characteristics in which the aerodynamic forces are derived from low-aspect-ratio theory, strip theory, and three-dimensional forces. A closed-form solution is developed using low-aspect-ratio forces for certain stiffness distributions. An iteration procedure is developed for arbitrary stiffness distributions. The analytical results are compared to experimental results on a series of model wings of varying sweep angle over the Mach Number range from subsonic to hypersonic.

THE EQUATION OF ENERGY BALANCE FOR FLUTTERING SYSTEMS WITH SOME APPLICATIONS IN THE SUPERSONIC REGIME. J. D. C. Crisp. IAS 27th Annual Meeting, New York, Jan. 26-29, 1959, Rep. 59-57. 31 pp. 23 refs. Members, $0.50; nonmembers, $1.00. Presentation of an energy balance equation for a finite number of degrees of freedom of a three-(or two-) dimensional linear system. Emphasis is placed on the time-dependence of system parameters and the validity for divergent and subsident oscillations. Specialization is made to neutrally stable oscillations, thence to binary

three-dimensional flutter. A criterion of "ultimate stability" is established for this case. Several examples of supersonic flutter, including wing-bending-torsion flutter, wing-aileron flutter, and panel flutter, illustrate the application and limitations of the equation of energy balance.

AN ANALYSIS OF FLIGHT-TEST MEASUREMENTS OF THE WING STRUCTURAL DEFORMATIONS IN ROUGH AIR OF A LARGE FLEXIBLE SWEPT-WING AIRPLANE. Appendix - RELIABILITY OF RESULTS. H. N. Murrow. US, NASA Memo. 12-3-58L, Jan., 1959. 46 pp. Application of power spectral techniques to the derivation of frequency-response functions for the deflection and twist responses at three spanwise locations to vertical gusts, and comparison of results with those obtained for a reference quasi-static airplane. Results indicate that the deflections in rough air are generally amplified by a small amount, while the streamwise twists are amplified by factors of the order of 2.0. On a frequency basis, the maximum amplifications for both deflection and twist occur in the region of the first wing bending-mode frequency. An analysis of the effects of the deflection velocity and twisting motions on the local angles of attack is also presented.

ELECTRONICS

Communications

WAVE PROPAGATION THROUGH IONIZED GAS IN SPACE COMMUNICATIONS. F. J. Tischer. IAS 27th Annual Meeting, New York, Jan. 26-29, 1959, Rep. 59-34. 7 pp. Members, $0.50; nonmembers, $1.00. Analysis of the interaction of a radio wave with charged particles and of the resulting phenomena. The results are then applied to finding out how the various functions performed by the use of radio are affected by the phenomena. The models that are derived are based on idealized boundary conditions. Some of the phenomena are the following: frequency band restriction, attenuation, multiple path transmission, phase velocity deviations, antenna effects, modulation effects, and excess noise.

FUELS & LUBRICANTS

LEISTUNGSGRENZEN KLASSISCHER FESTTREIBSTOFFE. Rolf Engel. (DGRR Symposium, Essen, Oct., 1958.) Raketentech. & Raumfahrtforsch., Jan., 1959, pp. 14-18. In German. Determination of performance characteristics and limitations of solid propellants on the basis of a relationship existing between the grain and performance parameters, such as impulse, flow rate, and burning rate. Results are limited to nitroglycerin and nitrocellulose agents.

GÜNSTIGSTE FORMEN FESTER TREIBSTOFFE. U. T. Bödewadt. (DGRR Symposium, Essen, Oct., 1958.) Raketentech. & Raumfahrtforsch., Jan., 1959, pp. 19-24. In German. Discussion covering the problem of developing a solid rocket engine for a short burning time which may be reduced to that of obtaining a certain mass ratio for a given payload. Variations of the length of the engine with a fixed diameter are limited by the ratio of burning surface to throat area. These investigations lead to conditions for the selection of maximum parameters, in particular, the diameter of cylindrical grains.

THE IGNITION BEHAVIOR OF VARIOUS AMINES WITH WHITE FUMING NITRIC ACID. R. L. Schalla and E. A. Fletcher. ARS J., Jan., 1959, pp. 33-39. Study of the effects of fuel-oxidant ratio, charge density, and ambient atmosphere for amine-acid ignition determination. A number of amines are studied, and experimental results described. It is concluded that spontaneous ignition depends on the synergetic behavior of several reactions, the most important of which are a liquid phase neutralization reaction for aliphatic amines, a liquid phase nitration reaction for aromatic amines, and a slower, rate determining oxidation reaction which follows the others. Too rapid mixing can quench ignition if the mixture ratios, favoring the various reactions leading to ignition, are too widely separated.

IMPROVEMENTS IN THE OPERATING CHARACTERISTICS OF N-PROPYL NITRATE. R. W. Lawrence and W. P. Knight. ARS J., Jan., 1959, pp. 29-32. Summary of chemical aspects in the development of a gas generator using n-propyl nitrate. The methods employed to reduce the chamber temperature and carbon formation are described. It is shown that carbon deposition is successfully reduced by additive ferrocene. Attempts to reduce the chamber temperature were only partially successful.

INFLUENCE D'ADDITIFS SUR L'INFLAMMATION DE MELANGES HYDROCARBURE-AIR A PRESSION REDUITE. M. Guinet. La Recherche Aéronautique, Nov.-Dec., 1958, pp. 43-52. In French. Experimental investigation of the effect of additives on the flammability of hydrocarbon-air mixtures in order to improve the reigniting properties of kerosene at reduced pressures. The three arrangements used to eliminate effects other than those due to the chemical composition of additives are described. Among the substances tested only four, capable of spontaneous combustion in air, particularly boron derivatives, have shown promising results.

LES SOURCES D'ENERGIE POUR REACTEURS-FUSEES ET LEURS DOMAINES D'APPLICATION. M. Vernet-Lozet. Tech. & Sci. Aéronautiques, Aug., 1958, pp. 153-163. In French. Outline of the main characteristics of energy sources for rocket engines and their specific applications. Three categories of energy supply are defined: thermochemical, thermonuclear, and electronuclear. The study covers characteristic properties of liquid propellants; criteria related to the use of a propellant, such as economic aspects, handling and storage, and problems of ignition and combustion temperature; and use of liquid oxygen, nitric acid, peroxide, liquid ozone, as well as boranes, lithium hydrides, and free radicals.

INSTRUMENTS

Flow Measuring Devices

THE FREE MOLECULE PROBE AND ITS USE FOR THE STUDY OF LEADING EDGE FLOWS. J. A. Laurmann. Phys. Fluids, Nov.-Dec., 1958, pp. 469-477. 14 refs. USAF-Navy-supported description of a free molecular probe developed for use in the investigation of two-dimensional rarefied gas flows. Measurement of the probe temperature and heat transfer characteristics yields information that can be related theoretically to the state of the flowing gas. The use of such information is discussed with regard to the study of the qualitative nature of supersonic flow about sharp leading edges in regions where rarefaction, slip, and boundary layer-shock wave interaction effects are important. The results showed clearly the effect of increasing density.

MISSILES, ROCKETS

THE DIFFERENCES BETWEEN SATELLITE AND BALLISTIC MISSILE RE-ENTRY PROBLEMS. F. R. Riddell and J. D. Teare. Avco Res. Lab. RR 31, Sept., 1958. 30 pp. 12 refs. Quantitative comparison of satellite and ballistic missile re-entries with respect to heating rates, total heat input, and decelerations encountered. Precise calculations are used to determine the range of validity of the linear analysis and to permit a general assessment of the re-entry of nonlifting satellite vehicles. The time-integrated heat input and the peak rate are considered. The effect of lift on the heating problem is briefly discussed by considering a specific case of satellite re-entry. The satellite is shown to present re-entry problems that are markedly different from those of ballistic missiles. The satellite experiences much lower decelerations and the significant heating occurs at higher altitudes than for a ballistic missile.

SOME VARIATIONAL SOLUTIONS TO ROCKET TRAJECTORIES OVER A SPHERICAL EARTH. Angelo Miele and J. O. Cappellari, Jr. Purdue U. Sch. Aero. Eng. Rep. A-58-9 (AFOSR TN 58-1012) [AD 206155], Nov., 1958. 29 pp. 10 refs. Development of general equations for analyzing the optimum flight paths of rocket-powered vehicles. The variational problem is investigated within the general frame of problems of the Mayer type. Three classes of trajectories are studied: constant altitude paths, vertical paths, and gliding paths. Closed-form solutions are obtained for the opimizing conditions associated with constant altitude flight and vertical flight. In addition, a general iterative procedure is introduced in connection with the extremal solution for gliding flight.

INERTIAL GUIDANCE FOR HYPERSONIC AND ORBITAL VEHICLES. Appendix - DERIVATION OF LINEAR GUIDANCE MODEL. G. W. Johnson and R. B. MacDonald. IAS 27th Annual Meeting, New York, Jan. 26-29, 1959, Rep. 59-33. 12 pp. Members, $0.50; nonmembers, $1.00. Development of a linear error generating model for inertial guidance. The model assumes that the true vehicle trajectory is constrained to an inertial great circle, and defines the errors due to computing vehicle position from data supplied by a "semi-ideal" inertial instrumentation. The semi-ideal inertia instrumentation assumes the existence of an orthogonal 3-axis accelerometer set mounted on a platform whose angular orientation is gyro stabilized. The error sources considered are initial orientation and position errors, plus gyro and accelerometer errors. The linearized equations, which define the six degrees of freedom in guidance error, are seen to be separable into a lateral and longitudinal mode with distinct dynamic properties. In general, the lateral-azimuth coupling results in a reduction of the contribution of azimuth errors to lateral error.

LOW-THRUST ROCKET STEERING PROGRAM FOR MINIMUM TIME TRANSFER BETWEEN PLANETARY ORBITS. C. R. Faulders. SAE Natl. Aero. Meeting, Los Angeles, Sept. 29-Oct. 4, 1958, Preprint 88A. 20 pp. Analysis of the problem of a minimum-time steering program for a low-thrust rocket with constant thrust-acceleration going from one planetary orbit to another. Formal methods of the calculus of variations are employed. The assumed boundary conditions are zero radial velocity at the initial and final radii, and initial and final angular momenta equal to the local circular values; other simplifying assumptions are made. Results of numerical integration are presented for a thrust-to-mass ratio of 10^{-4} Earth "g" and a final-to-initial radius ratio of 1.5.

NUCLEAR ENERGY

KERNVERBRENNUNGSPLASMEN UND MAGNETISCHE KERNBRENNKAMMERN FÜR STRAHLTRIEBWERKE. F. Winterberg. Astronautica Acta, Fasc. 4, 1958, pp. 235-263. 13 refs. In German. Discussion of the properties of fusion and fission plasmas in terms of their application to rocket propulsion. Special arrangements of magnetic fields for confining the plasmas are proposed in order to prevent contact of the hot plasmas with combustion chamber walls. Several methods for converting directly the nuclear energy into electrical energy in order to maintain the necessary high magnetic fields are considered. Includes discussion of possible combinations of the developed methods.

POWER PLANTS

Jet & Turbine

COMPARISON OF CALCULATED AND EXPERIMENTAL TOTAL-PRESSURE LOSS AND AIRFLOW DISTRIBUTION IN TUBULAR TURBOJET COMBUSTORS WITH TAPERED LINERS. Appendix A, B - **INCOMPRESSIBLE-FLOW CALCULATIONS FOR TUBULAR TURBOJET COMBUSTORS WITH TAPERED LINERS.** J. S. Grobman. US, NASA Memo. 11-26-58E, Jan., 1959. 48 pp. Study of the effects of combustor geometry and operating variables on pressure loss and airflow distribution.

Calculations include the effects of momentum transfer between annulus and liner gas streams, annulus wall friction, heat release, and discharge coefficients of liner air-entry holes. Generalized curves are presented, showing the effects of liner wall inclination, liner open hole area, and temperature rise across the combustor on pressure loss and airflow distribution for a representative parabolic linear hole distribution.

NOTES ON AIR BREATHING ENGINES FOR SUPERSONIC FLIGHT. A. W. Morley. RAeS J., Jan., 1959, pp. 23-34. 10 refs. Description and evaluation of various engine designs. The problems of the supersonic air intake, the thrust-minus-drag of the propulsive system, the combustion system, and the final propelling nozzle are considered. Several features that need developing to the highest possible standard are outlined, and the performance of various power plants is represented graphically.

Ram-Jet & Pulse-Jet

ÜBER ZÜNDUNG UND VERBRENNUNGSABLAUF IN PULSIERENDEN STRAHLTRIEBWERKEN UND DEREN ANWENDUNGEN. F. Staab. DFL Inst. Strahltriebwerke Bericht No. 91, 1958. 24 pp. 41 refs. In German. Investigation of the ignition and combustion processes in pulse-jet power plants in order to obtain a higher rate of thrust per unit cross section of combustion chamber. The study covers evaluation of the advantageous characteristics of easily ignited nuclei which are the product of the unburnt mixture and the new intake, and discussion of means of producing similar combustion conditions in other jet engine types, considering certain noise reduction factors. Included are such methods as modification of flame tubes, separate preheating of fuel and air, and injection of premixed fuel/air in addition to the normal mixing cycle.

Rocket

PROPELLANT VAPORIZATION AS A CRITERION FOR ROCKET-ENGINE DESIGN; EXPERIMENTAL PERFORMANCE, VAPORIZATION, AND HEAT-TRANSFER RATES WITH VARIOUS PROPELLANT COMBINATIONS. Appendix A, B - RELATION BETWEEN GAS VELOCITY AND PERCENT OF PROPELLANTS VAPORIZED. Appendix C - FINAL GAS VELOCITY CALCULATIONS. Appendix D - HEAT-TRANSFER CALCULATIONS. B. J. Clark, Martin Hersch, and R. J. Priem. US, NASA Memo. 12-29-58E, Jan., 1959. 31 pp. 15 refs. Experimental determination of characteristic exhaust velocity and combustion efficiency of a nominal 200-lb.-thrust engine for eleven propellant combinations at several chamber lengths for a spray formed by two impinging jets. Hydrogen with any oxidant was found to give the highest efficiency. A comparison of experimental and analytical results with calculations, based on the assumption that vaporization of the propellant determines the rate of combustion, showed fair agreement except for ammonia-fluorine and hydrazine combinations. Over-all heat-transfer rates were measured for each combination. These rates compared well with the values predicted by standard heat-transfer calculations except for combinations using ammonia.

WHAT IS SPECIFIC IMPULSE WORTH? E. R. Hinz. IAS 27th Annual Meeting, New York, Jan. 26-29, 1959, Rep. 59-23. 15 pp. Members, $0.50; nonmembers, $1.00. Analysis of the effect of specific impulse on ballistic missile and orbital booster performance, design, and economics. The chemical conversion equation for specific impulse is presented. The performance and physical characteristics of a number of propellants are tabulated. The increase in propulsion system complexity due to the improvement in range, altitude, and payload, as well as propellants handling problems are considered. Some of the conclusions drawn are: (a) small changes in specific impulse have a powerful influence on the performance of both ballistic missiles and orbital boosters; (b) although higher specific impulses are desirable, LOX/RP-1 systems appear the most resonable for large orbital boosters of the immediate future.

PROPELLERS

PROPELLER STATIC THRUST. K. S. Coward. Aero/Space Engrg., Mar., 1959, pp. 64-68. 19 refs. Presentation of the available test data and a general method for the rapid computation of static thrust using a static efficiency term. Examples and test data are given for ducted and unducted cases. It is concluded that test data which exist at the present time are incomplete and sometimes contradictory, and more theoretical and experimental investigations are needed.

RESEARCH, RESEARCH FACILITIES

Wind Tunnels

CONTRIBUTION DE LA VISUALISATION A L'ETUDE DE L'ECOULEMENT A FAIBLE VITESSE DANS DES MAQUETTES DE COMPRESSEURS CENTRIFUGES. J. Le Manach and E. Robert. La Recherche Aéronautique, Nov.-Dec., 1958, pp. 21-34. In French. Evaluation of the role of visualization in the study of low-speed flow in centrifugal compressor models for obtaining further information on the internal aerodynamic field of rotating machines. Experimental results obtained on two models are presented and certain observed phenomena are described. These include: the presence of a turbulent zone over the overpressurized face, predicted by theory; the separation which occurs under certain operating conditions in the diffuser wheel; and the turbulent separation. The described results include various types of diffusers; certain recommendations for tests in a water tank are given.

ROTATING WING AIRCRAFT, HELICOPTERS

A THEORETICAL APPROACH TO SOME ROTOR BLADE FLUTTER AND FORCED VIBRATION PROBLEMS. W. E. Hooper. Helicopter Assn. Gt. Brit. J., Dec., 1958, pp. 282-307.

Development of a method for predicting the flutter boundaries of a helicopter rotor blade in order to provide an illustration of the effects of fundamental characteristics of the blade on the flutter boundaries. A basic approach is proposed which may be expanded to provide more detailed representation of any particular blade problem, and an example, yielding some useful qualitative results, is analyzed. It is shown that reducing the control stiffness lowers the flutter speed, and that the flutter speed is very sensitive to movement of the mass axis and relatively insensitive to changes of "delta three," elastic axis, and blade structural damping.

SPACE TRAVEL

MOTION OF A SATELLITE AROUND AN UNSYMMETRICAL CENTRAL BODY. R. R. Newton. J. Appl. Phys., Jan., 1959, pp. 115-117. Navy-supported analysis showing that, unless a satellite is initially in a large enough orbit, it may strike the central body, even in the absence of dissipative forces. A solution for the motion in a special case is presented, using a simplified model. It is shown that there are two limiting confocal ellipses to which the trajectory is alternately tangent, the motion being quasi-ergodic within these two ellipses. The number of revolutions which the satellite will make before striking the constraining surface is estimated. Application to satellites of the moon is made. It is shown that even a small asymmetry in a central body can affect appreciably the orbit of a near satellite.

REDUCTION OF FLIGHT TIME AND PROPELLANT REQUIREMENTS OF SATELLITES WITH ELECTRIC PROPULSION BY THE USE OF STORED ELECTRICAL ENERGY. Morton Camac. Avco Res. Lab. RR 36 (AFOSR TN 58-1013) [AD 206156], Oct., 1958. 26 pp. Study of several missions in the gravitational field of the Earth and comparison of the payload mass ratio as a function of the flight time when electrical propulsion is used. It is shown that, for trips starting from a low circular orbit to a larger circular orbit and subsequent return to the Earth, the incorporation of electrical energy storage can reduce the flight time while increasing the payload mass ratio. The extent to which this storage is an advantage is determined: (1) by the specific mass of the electrical propulsion system, and (2) by the relative decrease in the impulse requirement for the pulsed flight plan compared to the spiral orbit.

STRUCTURES

Beams & Columns

SIMPLIFIED COMPUTATIONS OF NON-UNIFORM BEAM CONSTANTS BY THE METHOD OF COMPLEMENTARY I_0/I DIAGRAM. Sung Chi-Ken and Tsai Fang-Yin. Scientia Sinica, Nov., 1958, pp. 1,076-1,109. 15 refs. Presentation of a method for calculating the various constants of nonuniform beams by segregating the computations into those of a uniform beam and those of the haunched parts at its two ends. The curve of the complementary I_0/I diagram at either end is substituted by a cubic parabola in computing the values of the integrals F, which are used to compute the values of the angle change coefficients ϕ^a and ϕ^e. The formulas for the various shape and load angle-change coefficients ϕ^a are given for six basic cases of loading in terms of the integral F. The tables of J-values used in computing F are also given.

Cylinders & Shells

BUCKLING OF A CYLINDRICAL SHELL UNDER A CIRCUMFERENTIAL BAND LOAD. D. O. Brush and F. A. Field. IAS 27th Annual Meeting, New York, Jan. 26-29, 1959, Rep. 59-5. 13 pp. Members, $0.50; nonmembers, $1.00. Presentation of a method to determine the buckling pressure of a long cylindrical shell. The results are applicable to structural design for the resistance of loads applied by ground handling support frames, and to the thermal stress analysis of shells subjected to heating while encircled by heavy rings. Two methods of loading are considered. Results are presented in graphical form. It is shown that where radius/thickness ratios are greater than 200 and pressure band width/radius ratios less than 1.0, buckling pressures for the ring pressure loading are as much as 30% greater than those for fluid pressure loading. Except for very wide pressure bands, the buckling pressures are approximately in inverse proportion to band width for both kinds of loading.

RESPONSE OF SHALLOW VISCOELASTIC SPHERICAL SHELLS TO TIME-DEPENDENT AXISYMMETRIC LOADS. P. M. Naghdi and W. C. Orthwein. U. Mich. Res. Inst. TN 4 (AFOSR TN 58-993) [AD 205905], Nov., 1958. 24 pp. 18 refs. Solutions, employing the differential equations governing the transverse motion of thin shallow elastic shells, are obtained with the joint use of Laplace and Hankel transforms which, by interchanging the order of the inversions, avoid an otherwise intricate task of contour integration in the complex Laplace transform-plane. Explicit results in integral form are deduced for viscoelastic shells under instantaneous pulse loading (including those uniformly distributed about and concentrated at the apex), and are particularized to the cases of Maxwell and Kelvin solids. The solutions for a shallow elastic shell and for a flat plate are also given as by-products of the general solution.

Sandwich Construction

A NEW THEORY OF ELASTIC SANDWICH PLATES; ONE-DIMENSIONAL CASE. Yi-Yuan Yu. Polytech. Inst. Bklyn., Dept. Mech. Eng. TN 1 (AFOSR TN 58-896) [AD 204133], Oct., 1958. 25 pp. Development of a new flexural theory of isotropic elastic sandwich plates from the theory of elasticity. The theory includes the effects of transverse shear deformation and rotatory inertia in both the core and faces of the sandwich, while no limitations are imposed upon the magnitudes of the ratios between the thickness, material densities, and elastic constants of the core and faces. Results are applied to the problem of bending of a cantilever plate subjected to load at the unsupport-

ed end, and the problem of propagation of straight-crested waves in an infinite plate.

THERMO-ELASTIC BEHAVIOR OF SIMPLY-SUPPORTED SANDWICH PANEL UNDER HIGH TEMPERATURE GRADIENT AND EDGE COMPRESSION. Appendix - DERIVATION OF GENERAL DIFFERENTIAL EQUATIONS AND BOUNDARY CONDITIONS OF SANDWICH PANELS; PRINCIPLE OF MINIMUM POTENTIAL ENERGY. Chieh-Chien Chang and I. K. Ebcioglu. IAS 27th Annual Meeting, New York, Jan. 26-29, 1959, Rep. 59-67. 18 pp. 15 refs. Members, $0.50; nonmembers, $1.00. AFOSR-supported analysis of the thermal elastic behavior of a rectangular sandwich panel which is subjected to edge compression and transverse load, as well as to a high temperature difference between the two faces. The differential equations and boundary conditions are derived from the principle of variational potential energy. For the case of simply supported panel, an analytic theory is presented to solve for the displacements, the deflection, and the stresses. As a limiting case, an infinitely wide sandwich panel under cylindrical bending is also treated. To illustrate the application, the case of a 17-7PH stainless steel sandwich panel with one face at 900°F. and the other at 100°F., under both edge compression and transverse load, is treated. The maximum stresses on both faces are given as a function of edge compression.

SIMPLE THICKNESS-SHEAR MODES OF VIBRATION IN INFINITE SANDWICH PLATES. Yi-Yuan Yu. Polytech. Inst. Bklyn., Dept. Mech. Eng. TN 2 (AFOSR TN 58-897) [AD 204132], Oct., 1958. 15 pp. Derivation of closed-form solutions from the elasticity theory in which the mode shapes are found to be represented by single trigonometric functions. The antisymmetric mode is further solved according to the new flexural theory of sandwich plates. By matching the lower frequency calculated from the sandwich-plate theory within the corresponding fundamental frequency from the elasticity theory, the value of a shear coefficient in the sandwich-plate theory may be determined directly. It is shown that for sandwich plates the shear coefficient is not constant and may have a value very close to unity, in contrast to its constant value of $\pi^2/12$ for homogeneous plates given by Mindlin.

Thermal Stress

LARGE DEFLECTIONS OF STRUCTURES SUBJECTED TO HEATING AND EXTERNAL LOADS. M. J. Turner, E. H. Dill, H. C. Martin, and R. J. Melosh. IAS 27th Annual Meeting, New York, Jan. 26-29, 1959, Rep. 59-56. 19 pp. Members, $0.50; nonmembers, $1.00. Extension of a method for direct formulation of the stiffness matrix to include the effects of nonuniform heating and large deflections. The usual stiffness formulation is limited to small temperature changes and small deflections. For large temperature changes additional terms are required. Also, the problem becomes geometrically nonlinear when large deflections are involved. The force-deformation relations necessary for a step-by-step or iterative procedure are derived for an axially loaded member and for a plate element including the effects of thermal strains. A simple box beam is analyzed to illustrate the application of the general method.

STRESS RELAXATION IN STRUCTURAL MATERIALS. A. M. Freudenthal. USAF WADC TR 58-168 [AD 202497], Oct., 1958. 39 pp. 29 refs. Study of the phenomenon of stress-relaxation in relation to its physical origin, its mathematical representation, and its experimental determination - with particular emphasis on the interrelation between creep and relaxation in metals and in polymers. While the relaxation behavior of materials is of primary importance in design, it appears that neither the present methods of direct "relaxation testing" nor the conversion of creep-data into relaxation-data provide useful and reliable information concerning the relaxation behavior of the material.

DIRECT-ANALOG METHOD OF ANALYSIS OF THE INFLUENCE OF AERODYNAMIC HEATING ON THE STATIC CHARACTERISTICS OF THIN WINGS. M. A. Basin, R. H. MacNeal, and J. H. Shields. J. Aero/Space Sci., Mar., 1959, pp. 145-154. Application of the direct-analog computer method to the problem of thermal stress in thin wings. A general method of analysis of temperature effects on structures is presented. The method is then applied to the example of a square, cantilever, constant-depth wing box symmetrically heated along the leading and trailing edges. The thermal in-plane stresses and the lateral load influence coefficients are calculated using an electric analog computer. Results are presented and compared for the heated and unheated wing.

THEORETICAL ANALYSIS OF THE HEATING OF A COMPOSITE SLAB, WITH APPLICATIONS TO THE KINETIC HEATING OF AN AIRCRAFT WING. Appendix I - SOLUTION OF THE HEAT FLOW EQUATIONS FOR A COMPOSITE SLAB. Appendix II - TEMPERATURE DISTRIBUTION WITH THE HEAT CAPACITY OF THE INSULATION NEGLECTED. Appendix III - SCHEMATIC REPRESENTATIONS OF THE DEUCE PROGRAMMES. E. C. Capey and K. I. McKenzie. Gt. Brit., RAE TN Struc. 243, June, 1958. 27 pp. Derivation of the transient temperature distribution for a composite slab, heated by raising the air temperature on one side at a constant rate to a maximum. Numerical results are evaluated on a digital computer from the theoretical solution, which is obtained in series form. Results are obtained for the temperature difference across the skin in an aircraft wing covered by insulative material; these results show that the effect of the insulative material could be calculated with sufficient accuracy by neglecting its heat capacity.

HEAT CONDUCTION IN A MELTING SLAB. S. J. Citron. IAS 27th Annual Meeting, New York, Jan. 26-29, 1959, Rep. 59-68. 23 pp. 16 refs. Members, $0.50; nonmembers, $1.00. Study of the behavior, after the initiation of melting, of a

slab insulated on one side and subjected to a heat input varying arbitrarily with time on the other side. A method of successive approximations is developed which requires the solution of an ordinary nonlinear differential equation. Since any heat input is permitted, solutions by this method may be used to match conditions resulting from the aerodynamic heating problem. Curves of melt-thickness versus time are presented for a constant heat input and for a typical heat input incurred by a body descending through the atmosphere.

ANISOTROPIC COMPOSITE THERMAL STRUCTURES FOR HYPERSONIC FLIGHT. Luigi Broglio. IAS 27th Annual Meeting, New York, Jan. 26-29, 1959, Rep. 59-66. 23 pp. Members, $0.50; nonmembers, $1.00. USAF-sponsored presentation of two fundamental solutions: (a) the temperature distribution produced by an instantaneous heat source, and (b) the thermoelastic motion produced by an instantaneous heat source. Integration with respect to time and space of the two solutions gives the results for any time and space variable heat-source distribution. Numerical examples show the possibility of a substantial decrease in maximum temperature at the outer surface and a substantial increase of insulation at the inner surface even by the use of simpler designs.

BERECHNUNG DER BEULWERTE VON PLATTEN UNTER UNGLEICHMÄSSIGER TEMPERATURBEANSPRUCHUNG NACH DEM MEHRSTELLENVERFAHREN. W. Schnell and G. Fischer. DVL Bericht No. 78, Nov., 1958. 35 pp. 17 refs. Westdeutscher Verlag, Köln & Opladen. In German. Development of a method for calculating the buckling values of plates subjected to thermal stress. The procedure is used to determine the critical stresses leading to the buckling in the skin of a wing cross section for any temperature distribution. Illustrative examples are presented for comparing the results of this calculation with those obtained by other methods.

THERMODYNAMICS

Combustion

A STUDY OF OXIDATION OF HYDROGEN BASED ON FLASHBACK OF HYDROGEN-OXIGEN-NITROGEN BURNER FLAMES. B. D. Fine. US, NASA Memo. 12-23-58E, Jan., 1959. 31 pp. 16 refs. Measurements of flashback at reduced pressures as a function of burner diameter, pressure, and mixture composition. On the assumption that the critical boundary velocity gradient for flashback is a measure of the mean reaction time within a flame, the data are used to evaluate parameters in the rate expression for the flame reaction. The reaction order with respect to oxygen was about 0.9 and that for hydrogen was about 1.4, independent of flame temperature.

SPRAY COMBUSTION AND ATOMIZATION. F. A. Williams. Phys. Fluids, Nov.-Dec., 1958, pp. 541-545. 12 refs. Army-supported presentation of a statistical formalism for describing the behavior of sprays that includes the formation of new droplets, collisions, and aerodynamic forces. Criteria for the efficiency of impinging jet atomization are also presented. It is shown that if the incident jets have a size distribution of a generalized Rosin-Rammler type, the resulting spray belongs to the same class of distributions. The size history of evaporating sprays is also obtained from the theory. A spray combustion analysis given by Probert is extended to include more general size distributions and the effects of droplet interactions and the relative motion of the droplets and the fluid.

ETUDE SPECTROGRAPHIQUE D'UNE FLAMME STABILISEE DANS UN ECOULEMENT. Marcel Barrère and Simone Barrère. La Recherche Aéronautique, Nov.-Dec., 1958, pp. 11-19. 10 refs. In French. Description of a spectrographic study of flames stabilized by obstacles at high speed ($R_e > 10^4$). The method for combustion zone analysis is described and it is shown that measurements of the intensities of CH and C_2 chains provide continuous information on the flame propagation in a specific part of the chamber, give the topography of active combustion zones, and provide means for verifying the stabilization mechanism. The evaluation of experimental results covers the onset of combustion, qualitative and quantitative studies of flames stabilized by obstacles, and the distribution of intensities at blowoff limits.

VTOL & STOL

FLIGHT INVESTIGATION OF THE STABILITY AND CONTROL CHARACTERISTICS OF A 1/4-SCALE MODEL OF A TILT-WING VERTICAL-TAKE-OFF-AND-LANDING AIRCRAFT. L. P. Tosti. US, NASA Memo. 11-4-58L, Jan., 1959. 17 pp. Experimental investigation consisting of hovering flights in still air, vertical take-offs and landings, and slow constant-altitude transitions from hovering to forward flight. A description of the test model, equipment, and installation is made. The stability and control characteristics of the model were generally satisfactory except for the following characteristics: (1) in hovering flight, the model had an unstable pitching oscillation of relatively long period; (2) at very low speeds and angles of wing incidence of the order of 70°, the model experienced large nose-up pitching moments which severely limited the allowable center-of-gravity range.

RESEARCH STUDIES ON A DUCTED FAN EQUIPPED WITH TURNING VANES. A. W. Gilmore and W. E. Grahame. IAS 27th Annual Meeting, New York, Jan. 26-29, 1959, Rep. 59-29. 15 pp. Members, $0.50; nonmembers, $1.00. Presentation of force, moment, and inflow distribution data obtained from wind tunnel tests of a ducted fan submerged in a body of elliptical plan form and cross section. The model was equipped with inlet and exit turning vanes for purposes of obtaining symmetrical duct inflow, control, and duct closure. Applications of the rheoelectric analogy to define the character of the flow into a duct under static and forward flight conditions are illustrated. An example is shown of the use of the guide vanes for trim control during transition.

XUM

An Evaluation of a Ground-Level Escape System. F. P. Marciniak and R. A. Houghton. *SAE Natl. Aero. Meeting, Los Angeles, Sept. 29-Oct. 4, 1958, Preprint 91A.* 24 pp. 12 refs. Evaluation of the Martin-Baker Mark A5 ejection system which features a rapidly deploying parachute.

Fuel Tanks

DC-8 Fuel System Design Considerations. M. A. O'Connor and W. B. King. *SAE Natl. Aero. Meeting, Los Angeles, Sept. 29-Oct. 4, 1958, Preprint 89A.* 19 pp. Design and operation of the fuel system, with emphasis on reliability and engine autonomy.

Boeing 707 Fuel System. E. J. Osols. (*SAE Natl. Aero. Meeting, Los Angeles, Sept. 29-Oct. 4, 1958, Preprint 89B.*) *SAE J.*, Dec., 1958, pp. 63-66.

Operating Characteristics, Economics

Design of Commercial Jet Aircraft for Specific Routes. M. L. Pennell. *SAE Natl. Aero. Meeting, Los Angeles, Sept. 29-Oct. 4, 1958, Preprint 86B.* 9 pp. Discussion of the factors which influenced the Boeing Airplane Co. to redesign its jet transport from a single basic model to a family of three basic models with many variations of each type.

Turboprop Versus Turbojet. F. H. Robertson. *Shorts Quart. Rev.*, Dec., 1958, pp. 2-8. Comparison of economic characteristics for aircraft using the two different power plants.

Piloting

A Ground-Based Take-Off Monitor System. J. S. Lukesh. *Interavia*, Dec., 1958, pp. 1,301, 1,302. Analysis of the take-off problem of supersonic aircraft, and description of a system to prevent pilot error due to inability to determine aircraft performance while still on the runway.

An Investigation of Optimal Zoom Climb Techniques. H. J. Kelley. *IAS 27th Annual Meeting, New York, Jan. 26-29, 1959, Rep. 59-16.* 19 pp. 23 refs. Members, $0.50; nonmembers, $1.00. Investigation of the climb problem of a turbojet aircraft using the Mayer formulation of the calculus of variations. The Euler-Lagrange equations governing optimum flight are integrated. Discontinuities in thrust are treated, and a comparison of arbitrary and optimum zoom techniques is made.

Aviation & Space Medicine

L'Etude de l'Activité Vitale des Animaux Lors des Vols en Fusées dans les Couches Supérieures de l'Atmosphère. Pokrowski. (*Congrès Internatl. Fusées & Engins-Guidés, Paris, Dec. 3-8, 1956.*) *Fusées*, Apr., 1958, pp. 5-7. In French. Description of experiments performed in USSR to determine the vital activity of animals during the flight through the upper layers of the atmosphere.

Man as a Monitor. A. E. Hickey, Jr., and W. C. Blair. *Human Factors*, Sept., 1958, pp. 8-15. 18 refs. Discussion of the use of the feedback principle in monitoring and continuous control situations. A simple feedback model is discussed and the associated variables identified. Ten monitoring or vigilance experiments are analyzed in terms of the model.

Viability Surveillance and Data Collection in Biosatellite Experiments. A. W. Hetherington. *IAS 27th Annual Meeting, New York, Jan. 26-29, 1959, Rep. 59-22.* 7 pp. Members, $0.50; nonmembers, $1.00. Discussion of means for obtaining four basic types of information from biosatellite experiments: (1) data on viability, (2) physiological status reports, (3) performance capability reports, and (4) miscellaneous research data of various kinds collected for their long term scientific value.

Biomedical Aspects of Space Flight. Don Flickenger. (*NATO AGARD General Assembly, Copenhagen, Oct. 20-29, 1958.*) *U.S., NASA Paper*, 1958. 27 pp. Review of problems associated with space exploration, including metabolic requirements in closed environments, anthropological aspects of capsule design, instrumentation for biological measurements, radiobiological hazards, and psychological hazards.

Some Results of Biological Experiments in Rockets and Sputnik II. A. G. Kousnetzov. (*3rd Europ. Congr. Av. Med., Louvain, Sept. 26, 1958.*) *J. Av. Med.*, Nov., 1958, pp. 781-784. Description of experimental investigations to determine the effect of space flight on living organisms; results are analyzed.

Some Biophysical and Medical Problems Involved in Manned Space Flight: A Review. Carl-Johan Clemedson. *Astronautik*, No. 1, 1958, pp. 9-36. 109 refs. Discussion covering the effects of gravitational stress, the loss of life-sustaining properties of the terrestrial atmosphere and of its filtration and protective properties, problems of food and water supply, and psychological stress.

Specific Factors in Space Cabin Design. I—Thermal and Gravitational Design Considerations with Sealed Cabins. E. G. Aiken. II—Prob-

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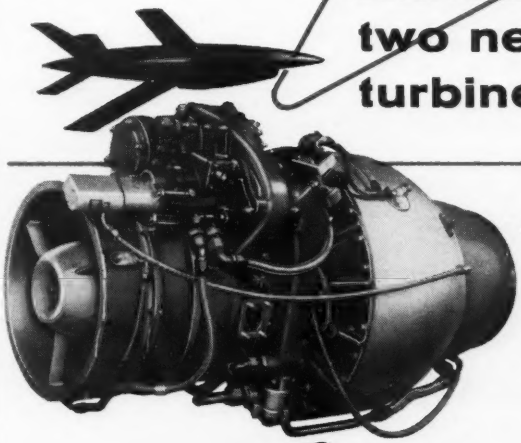

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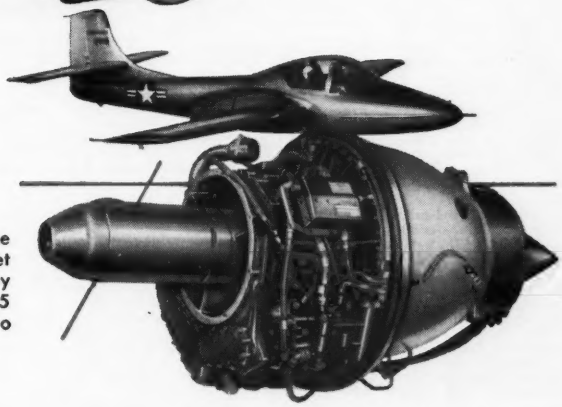

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lems of Respiration and Decomposition with Sealed Cabins. E. B. Konecci. *SAE Natl. Aero. Meeting, Los Angeles, Sept. 29-Oct. 4, 1958, Preprint 90B.* 34 pp. 28 refs.

Basic Consideration of Space Cabin Design. A. M. Mayo. *SAE Natl. Aero. Meeting, Los Angeles, Sept. 29-Oct. 4, 1958, Preprint 90A.* 7 pp. Discussion of design requirements considering the following: radiation, temperatures, acceleration, noise and vibration, meteoroids, internal atmosphere, and food and water supply.

Physiology of Launching and Re-Entry Stress in Rodents. H. J. Von Beckh. *USAF MDC TN 58-11 [AD 154105]*, Aug., 1958. 8 pp. 10 refs. Review of centrifuge runs with rodents, concluding that accelerative forces in themselves would not endanger these animals in bio-satellite experiments.

Air-to-Air Tracking During Closed-Loop Centrifuge Operation. J. L. Brown and C. C. Collins. *J. Av. Med.*, Nov., 1958, pp. 794–804.

The Relationship Between Cardiovascular Response and Positive *G* Tolerance. J. J. Zarriello, L. M. Seale, and M. E. Norsworthy. *(Aero Med. Assoc., 29th Annual Meeting, Wash., Mar. 26, 1958.)* *J. Av. Med.*, Nov., 1958, pp. 815–820. Determination of the relationship between pre-run clinical cardiovascular measures and criteria of visual impairment occurring during centrifugation. The experimental arrangement and the results are described.

Behavioral Effects of Whole Body Vibration. M. M. Mozell and D. C. White. *U.S., NADC MA-5802, TED ADC AE-1409, Rep. I*, Jan. 28, 1958. 17 pp. Study of the effect of whole body vibration on the ability of humans to read the digits of an aircraft mileage indicator and their ability to do a tracking task which simulates the control of an aircraft.

A Technique for Instrumenting Subgravity Flights. G. J. D. Schock and D. G. Simons. *USAF MDC TN 58-4 [AD 135008]*, Feb., 1958. 14 pp. Description of instrumentation designed to aid a pilot in obtaining the maximum duration of the weightlessness state and to quantitatively record the *g* forces acting on both the subject and the aircraft frame.

Apparent Motion of a Fixed Luminous Target During Subgravity Trajectories. G. J. D. Schock. *USAF MDC TN 58-3 [AD 135009]*, Feb., 1958. 12 pp. Study to determine the effects of linear acceleration and deceleration on the visual perception by man of a target in the dark.

The Influence of Pre-Exposure Luminance and Duration Upon Short-Course Dark Adaptations. L. R. Pinneo. *USAF RADC TR 58-24 [AD 148613]*, Feb., 1958. 12 pp. 10 refs. Study to determine the effect upon human vision of momentary exposures to intensities of light higher than adaptation level.

Analysis of Reticular and Cortical Post-Discharges Following Electrical Reticular Stimulation. A. Hugelin and M. Bonvallet. *USAF OSR TN 58-540 [AD 158356]*, 1958. 14 pp.

Experimental Study of Reticulo-Cortical Interrelationships. Proposal for a Theory of the Servo-Control of the Reticular Activity by a Diffuse Cortical System. A. Hugelin and M. Bonvallet. *(J. Physiol.*, No. 49, 1957, pp. 1,201–1,223.) *USAF OSR TN 58-539 [AD 158355]*, 1958. 26 pp.

Cortical Tonus and Control of the Motor Facilitation of Reticular Origin. A. Hugelin and M. Bonvallet. *(J. Physiol.*, No. 49, 1957, pp. 1,171–1,200). *USAF OSR TN 58-541 [AD 158357]*, 1958. 33 pp. 47 refs.

Acoustic Absorption Coefficients of the Surface of Laboratory Animals. Eugene Ackerman, R. W. Farwell, Fujio Oda, and Adam Anthony. *ASA J.*, Dec., 1958, pp. 1,105–1,111. USAF-supported investigation to determine the amount of energy entering the skin. Sound absorption measurements on mice, rats, and guinea pigs were made by means of reverberation chambers.

Human Engineering

Human Factors Recommendations for Flight Progress Strips. Kenneth Colman, Omer Lucier, and Douglas Courtney. *Courtney & Co. MR 1*, Oct. 1, 1957. 18 pp. Study of a new printed flight strip and of the human factors involved in its introduction. Recommendations based on a study of only one segment of the total system are made.

A Follow-Up Survey of Human Factors Research in Aircraft, Missiles, and Supporting Industries. J. A. Kraft. *Human Factors*, Sept., 1958, pp. 23–25.

Chemistry

Gravimetric Semi-Micro Determination of Phosphorus, as Quinoline Phosphomolybdate, in Organic Compounds. Appendix I—**Precipitation of Quinoline Phosphomolybdate.** Appendix II—**Drying and Weighing Procedures.** T. R. F. W. Fennell and J. R. Webb. *Gt. Brit., RAE TN Chem. 1335*, Sept., 1958., 12 pp.

Determination of Silicon by Precipitation of the Yellow Silico-Molybdic Complex by Quinoline. Marcel Armand and Jean Berthoux. *(Anal. Chim. Acta*, No. 8, 1953, pp. 510–525.) *Gt. Brit., RAE Lib. Transl. 774*, Oct., 1958. 15 pp. 11 refs.

Computers

TRIDAC, Simulateur de Vol pour Engins Guidés. J. J. Gait. *(Congrès Internatl. Fusées & Engins-Guidés, Paris, Dec. 3–8, 1956.)* *Fusées*, Apr., 1958, pp. 10–20. In French. Brief description of the design and operation of an analog computer for missile flight simulation, with particular emphasis on measurements involving six degrees of freedom.

Saab's High Speed SARA Data Processor in Operation. *Saab Sonics*, No. 26, 1958, pp. 8, 9.

AiResearch Flight Data Systems. R. J. Tatge and N. M. Brown, Jr. *New Frontiers*, Fall, 1958, pp. 17–19. Review of the development and production of flight data systems; their importance in contributing to the performance of military and commercial aircraft is discussed.

An Introduction to the Airways Modernization Board Program for Data Processing and Display. F. M. McDermott. *J. Air Traffic Control*, July, 1958, pp. 12–14, 23.

The Storage and Processing of Digital Data on Magnetic Tape. D. W. Willis. *Soc. Instr. Tech. Trans.*, Dec., 1958, pp. 182–189. 14 refs.

Digital Storage on Punched Tape. M. E. Theis. *Soc. Instr. Tech. Trans.*, Dec., 1958, pp. 178–182. Description of punched paper tape, the methods of coding digital information on it, and the equipment available for handling it as the input or output medium of a computer.

A Track Switching System for a Magnetic Drum Memory. D. D. Majumder. *Electronic Eng.*, Dec., 1958, pp. 702–705.

Ferroelectric Storage Devices. S. Morleigh. *Electronic Eng.*, Dec., 1958, pp. 678–684. 19 refs. Study of the storage properties of ferroelectric materials, particularly with reference to barium titanate single crystal capacitors.

Real-Time Airborne Digital Computers. G. L. Hollander. *ISA J.*, Dec., 1958, pp. 26–32. Study examining a central control computer as a component of a feedback loop and differentiating its characteristics from those of other computers.

Application des Ordinateurs aux Engins Spéciaux. J. Casteil. *(Congrès Internatl. Fusées & Engins-Guidés, Paris, Dec. 3–8, 1956.)* *Fusées*, Apr., 1958, pp. 8, 9. In French. Survey of some computer applications to problems of guidance, flight testing, and combustion, as well as data processing.

Control Theory

Analysis of Integral-Square Error in Sampled-Data Control Systems. Appendix I—**A Mean-Square Value Theorem.** Appendix II—**Modified *z*-Transform of the Multiplied Functions.** Appendix III—**Solution of Total Square Integral.** Appendix IV—**An Existence Proof of Total Square Integral.** Appendix V—**Some Notes on Stability.** B. H. Bharucha. *U. Calif. Inst. Eng. Res. Ser. 60/1206*, June 30, 1958. 48 pp. 11 refs.

A Non-Linear Theory of the Dynamical Behaviour of Pneumatic Devices. R. Jackson. *Soc. Instr. Tech. Trans.*, Dec., 1958, pp. 161–169. Development and application of a nonlinear theory to some simple systems, taking into account the saturation effects in pneumatic amplifiers. Results are found to agree well with experiment.

Effects of Small Changes in the Elements A_{ij} on the Zeros of A_{ij}. F. E. C. Culick. *RAeS J.*, Dec., 1958, pp. 898–901. Presentation of a method for determining approximately the effects of small changes in the characteristics of a dynamic system on its free motion.

Simulation and Systems Analysis. F. W. Pruden. *Canada, NAE Quart. Bul.*, July 1–Sept. 30, 1958, pp. 7–30. Definition of the simulation and systems analysis, and description of its specific applications.

Basic Characteristics of Automatic Control. *Instrumentation*, July–Aug., 1958, pp. 12–16. Discussion of five different modes of control: two-position, floating, proportional, proportional-plus-reset, and rate.

Relations Between Spectra Densities of Inputs and Outputs in Linear Servo Systems with Time-Variable Coefficients. M. Sundström. *KTH Aero. TN 45*, Aug. 29, 1957. 7 pp.

Short Account of the Theories for the Study of Servo Systems Defined by Linear Differential Equations with Constant Coefficients and Influenced by Stochastic Disturbances. M. Sundström and K. Flodin. *KTH Aero. TN 46*, 1957. 11 pp.

Documentation

An Evaluation of "Use Studies" of Scientific Information. Mortimer Taube. *Documentation Inc. Paper (AFOSR TN 58-1050) [AD 206987]*, Dec., 1958. 23 pp. 31 refs.

Some Statistical Sampling Concepts Applied to the Information Retrieval Process of Documentation Systems. H. M. Wadsworth and R. E. Booth. *Western Reserve U. Cen. Doc. & Commun. Res. TN 4 (AFOSR TN 58-765) [AD 201864]*, Aug. 19, 1958. 36 pp.

Education & Training

The Physicist's Viewpoint: The Function of Universities in the Aero-Space Engineering Education. S. F. Singer. *IAS 27th Annual Meeting, New York, Jan. 26–29, 1959, Rep. 59-13.* 5 pp. Members, $0.50; nonmembers, $1.00.

Use of Accident Data, Instructors' Comments and Students' Responses in Transition Flight Training. L. M. Seale and W. B. Webb. *(Aero Med. Assoc. 29th Annual Meeting, Wash., Mar. 29, 1958).* *J. Av. Med.*, Nov., 1958, pp. 805–809.

Prediction of Flight Training Attrition by Grade Slips for First Ten Flights. D. K. Triteo, B. B. Cobb, and W. F. Brown. *(Aero Med. Assoc. 29th Annual Meeting, Wash., Mar. 28, 1958.)* *J. Av. Med.*, Nov., 1958, pp. 827–831.

Military Pilot Selection; A Survey of Programs in United States, Canada, Great Britain and France. R. R. Burwell and S. B. Sells. *(Aero Med. Assoc. 29th Annual Meeting, Wash., Mar. 28, 1958.)* *J. Av. Med.*, Nov., 1958, pp. 832–841. 14 refs.

Electronics

Quarterly Progress Report No. 12, 15 April 1958 Through 14 July 1958. *Polytech. Inst. Bklyn., MRI Rep. R-452.12-58*, 1958. 87 pp. 47 refs. Summaries of papers prepared by the electrophysics group, microwave technique and devices group, and networks group.

Electronic Simulator Gives Countermeasures Targets. Leopold Sternlicht. *Electronics*, Dec. 19, 1958, pp. 78–80. Description of a simulator that provides jamming and interference waveforms required to reproduce effects of most known techniques. Single targets and target groups can be programmed in speed, course, pulse, and azimuth width.

Amplifiers

Servo Phase Control Shapes Antenna Pattern. E. W. Markow. *Electronics*, Jan. 2, 1959, pp. 50–52. Description of the operation of a phase-controlled UHF amplifier developed as a unit of a steerable antenna system. The angular phase error between input and output is kept at less than 2 degrees.

Antennas, Radomes

A Microwave Antenna with Rapid Saw-Tooth Scan. J. S. Foster. *Can. J. Phys.*, Dec., 1958, pp. 1,652–1,660. Description of several early models of rapid scanners, as well as of the saw-tooth scan with its advantages and limitations.

Fluted-Core Radome; New Method of Sandwich Construction. *Aircraft Prod.*, Dec., 1958, pp. 456–458. Description of a process that is a combination of the injection molding of reinforced plastics with the lost-wax technique.

Electrical Tests on CW-396A Rigid Radomes with AN/FPS-6 Antenna. Joseph Vaccaro. *USAF RADC TN 58-95 [AD 148672]*, Apr., 1958. 33 pp. Investigation to determine the effects of a radome on a radar height-finder antenna. Measurement techniques, test equipment, and test results are discussed.

Design and Construction of Equipment Used to Operate a Commercial Power Line as a Very Low Frequency Antenna. R. M. Golden, R. V. Langmuir, R. S. Macmillan, and W. V. T. Rusch. *CIT Elec. Eng. Dept. TR 3 (AFOSR TN 58-908) [AD 204514]*, Oct., 1958. 31 pp.

Circuits & Components

On Periodicity of States in Linear Modular Sequential Circuits. Bernard Friedland. *Columbia U. Dept. Elec. Eng. Sch. Eng. TR T-33/B (AFOSR TN 58-907) [AD 204515]*, Sept. 15, 1958. 20 pp.

Potentiometers for Missile Systems: Extreme Reliability Is the Keynote. W. J. MacDonald. *Missile Des. & Devel.*, Nov., 1958, pp. 22–24.

Communications

AF Communications Equipment: A Look Into the Future. J. H. Vogelman. *USAF RADC TN 58-96 [AD 148676]*, Mar., 1958. 11 pp. Study of proposals for application of new components to future communication equipment.

The "Third Method." J. F. H. Aspinwall. *Wireless World*, Jan., 1959, pp. 39–43. Description of the principles in three types of single sideband operations. These are the filter method, the outphasing method, and the duplicated filter circuit method.

Performance of Some Radio Systems in the Presence of Thermal and Atmospheric Noise. A. D. Watt, R. M. Coon, E. L. Maxwell, and R. W. Plush. *IRE Proc.*, Dec., 1958, pp. 1,914–1,923. 35 refs. Investigation in which the relative efficiency of various carriers and the interference factor of various types of noise are found to be dependent upon the characteristics of the

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communication system, as well as the characteristics of the carrier and noise.

F-108 Communication Avionics Unveiled. P. J. Klass. *Av. Week*, Dec. 29, 1958, pp. 58–62. Description of the AN/ARC-68 system which provides single or double sideband voice, teletype, and data link service.

"Ghosts," A Study of the False Intersections Arising from Triangulation of Unmatched Signals. P. M. Langendorf. *USAF RADC TN 58-169 [AD 148786]*, July, 1958. 24 pp.

Exploitation of Physical Phenomena for Communications. J. L. Ryerson. *USAF RADC TN 58-277 [AD 148939]*, Oct., 1958. 14 pp. 32 refs. Investigation of communications through natural ducts by the use of low frequency radio, sound, light, heat, and gamma rays.

Auroral Effects on Northern Communications. A. M. Peterson. *Mil. Electronics*, Dec., 1958, pp. 6–9. Discussion on the nature of the disturbance phenomenon and survey of the research being done to obtain further understanding.

Round-the-World Echoes. G. A. Isted. (*Congr. Internatl. Propagation Ondes Radio-Elec., Liège, Oct. 6–11, 1958.*) *Marconi Rev.*, 4th Quart., 1958, pp. 173–183. 13 refs. Discussion of the information available on the echoes of circulating signals and analysis of the observations received from a Soviet satellite and from VHF ionospheric scatter transmissions.

Meteor Activity as a Factor in Ionospheric Scatter Propagation. G. A. Isted. (*Congr. Internatl. Propagation Ondes Radio-Elec., Liège, Oct. 6–11, 1958.*) *Marconi Rev.*, 4th Quart., 1958, pp. 161–172. 18 refs. Discussion of the unique characteristics of transient echoes in relation to the observed characteristics of ionospheric scatter propagation.

Propagation at Great Heights in the Atmosphere. G. Millington. *Marconi Rev.*, 4th Quart., 1958, pp. 143–160. 10 refs. Analysis of the tropospheric propagation over the earth through an atmosphere—standard at small heights, but in which the refractive index approaches unity asymptotically at great heights.

Construction Techniques

Modular Design Concept for Integrated Electronic Systems. A. H. Wulfsberg. *Can. Aircraft Ind.*, Nov., 1958, pp. 21–23, 48. Description of the principles and applications of the modular design concept. The advantages offered are discussed.

Encapsulating Electronic Equipment. A. D. Sinning, Sr. *Mil. Electronics*, Dec., 1958, pp. 14, 15, 18. Evaluation of the properties of plastic materials for encapsulating electronic equipment.

Epoxy Casting of Electronic Circuitry. D. L. Harvey. *Can. Aircraft Ind.*, Oct., 1958, pp. 24–27.

Magnetic Devices

Ferromagnetic Resonance in Polycrystalline Ferrites. J. Snieder. *Appl. Sci. Res., Sect. B*, No. 3, 1958, pp. 185–232. 14 refs. Investigation of a number of quantities which are characteristic for the behavior of various ferromagnetic ferrites under the influence of high frequency electromagnetic fields, and interpretation of the data thus obtained in terms of the theory of ferromagnetic resonance.

Ferrite Cores for Communication Coils. R. C. Taylor. *W. U. Tech. Rev.*, July, 1958, pp. 113–127.

K Voprosu ob Otsutsvii Sverkhprovodimosti v Ferromagnetikakh. S. V. Vonsovskii and M. S. Svirskii. *AN SSSR Dokl.*, Sept. 11, 1958, pp. 204–207. 13 refs. In Russian. Study covering the problem of absence of superconductivity in ferromagnetics.

Networks, Filters

The Junction Transistor as a Network Element at Low Frequencies. III—Stabilization of the Operating Point, in Particular with Regard to Temperature Changes. J. P. Beijersbergen, M. Beun, and J. te Winkel. *Philips Tech. Rev.*, Nov., 1958, pp. 122–134.

Noise, Interference

The Temperature Dependence of Noise Temperature Ratio in Germanium Diodes. A. Hendry. *Brit. J. Appl. Phys.*, Nov., 1958, pp. 458–460.

Oscillators, Signal Generators

Intensity and Damping Dependence of Various Parameters Describing Spectra-Line Shapes. R. D. Waldron. *MIT LIR TR 128*, Sept., 1958. 26 pp. Presentation of analytical expressions for the frequency dependence of a damped harmonic oscillator system. Equations are given for the displacement of maxima of these parameters as a function of line strength and width (intensity and damping).

Piezoelectricity

On the Theory of Piezotransducers. K. V. Goncharov. *Sov. Phys.-Acous.*, Jan.-Mar., 1958, pp. 35–44. Translation. Derivation of general relationships which correlate the sensitivities of piezotransducers with their electrical impedances.

Radar

One Radar or Two for Surveillance Work. J. K. Todd. *Interavia*, Dec., 1958, pp. 1,302, 1,303. Discussion of the type of radar needed for air surveillance work up to 40,000 ft. It is concluded that a single 50 cm. radar with a 50 ft. aerial is acceptable within ICAO specifications.

Radar Video Enhancement by Storage Techniques. C. A. Tereszkiewicz and W. R. Tower. *Sperry Eng. Rev.*, June, 1958, pp. 20–26. 11 refs. Description of a method for enhancing the video in cases where high scanning speeds or time sharing between various radar data inputs are involved.

Simplified Radar Performance Testing. G. W. Pate. *Sperry Eng. Rev.*, Oct., 1958, pp. 34–40. Description of two radar performance testing devices designed for "go, no-go" operation by relatively unskilled operators. Basic design principles are reviewed and general operating procedures outlined.

An Integrated Approach to the Design of Mobile Tactical Electronic Systems. Appendix—Size and Weight of Hydraulic Lines. R. N. Skalwold and M. N. Scheiderich. *USAF RADC TN 58-260 [AD 148917]*, Oct., 1958. 41 pp. Comparison of the weight for a complete conventional radar system with that of a completely integrated system.

Reliability

Reliability Study of Communication Systems. Omar Wing. *Columbia U. Dept. Elec. Eng. Sch. Eng. TR T-32/B (AFOSR TN 58-890) [AD 204139]*, Sept. 15, 1958. 23 pp. Presentation of a new method of analysis for a communication system making use of the matrix method of the theory of linear graphs.

Airborne Electronic Component Failures. C. A. Golueke. (*SAE Natl. Aero. Meeting, Los Angeles, Sept. 29-Oct. 4, 1958, Preprint 83D.*) *SAE J.*, Dec., 1958, pp. 88–90.

Semiconductors

Semiconductor Surface Phenomena. Abraham Many. *Sylvania Tech.*, Oct., 1958, pp. 117–124. 33 refs. Discussion of slow and fast surface states of germanium and silicon, such as their density and energy distribution in the forbidden gap and their capture cross sections for holes and electrons.

High-Temperature Capabilities of Germanium Transistors. J. O. Dick. *Elec. Mfg.*, Jan., 1959, pp. 149–151, 204. Test results indicating that temperature stabilization techniques can provide reliable short-term operation of germanium transistors in small-signal amplifiers at 110°C. or higher.

New Types of Germanium Diodes and Their Circuit Applications. G. Grimsdell. *Electronic Eng.*, Dec., 1958, pp. 709, 710.

Transmission Lines

Transmission in a Rectangular Waveguide Loaded with an Arbitrary Number of Capacitive Screens. F. A. W. Van Den Burg. *Appl. Sci. Res., Sect. B*, No. 3, 1958, pp. 153–183.

Asupra Transmisiei Ghidate a Undelor Electromagnetice. Hugo Rosman and Alfred Braier. *Iaşi Politeh. Inst. Bul.*, Fasc. 3/4, 1957, pp. 143–148. In Rumanian, with summaries in Russian and French. Discussion of the propagation of electromagnetic waves and description of the wave guide used in the investigation.

Helix Waveguide Theory and Application. Hans-Georg Unger. *Bell System Tech. J.*, Nov., 1958, pp. 1,599–1,647. 14 refs.

Attenuation of the TE_{01} Wave Within the Curved Helix Waveguide. D. Marcuse. *Bell System Tech. J.*, Nov., 1958, pp. 1,649–1,662.

Wave Propagation

Far Field Scattering from Bodies of Revolution. K. M. Siegel. *Appl. Sci. Res., Sect. B*, No. 4, 1958, pp. 293–328. 22 refs. Analysis of the far zone scattering of plane electromagnetic waves by perfectly conducting bodies of revolution for all ratios of body dimension to wavelength.

On the Diffraction and Reflection of Waves and Pulses by Wedges and Corners. F. Oberhettinger. *J. Res.*, Nov., 1958, pp. 343–365 44 refs. Analysis of various problems arising in the theory of the excitation of a perfectly reflecting wedge or corner by a plane, cylindrical, or spherical wave field.

Equipment

Electric

Aircraft Electrical Systems; The Case for Unparalleled A. C. L. G. Hill. *Flight*, Dec. 12, 1958, pp. 907, 908. Discussion covering the units of various a.c. and d.c. systems.

L'Equipement Electrique du Bristol "Britannia." II—Distribution du Courant des Alternateurs; Organes de Répartition et Dispositifs de Sécurité. H. Lanoy. *Docaéro*, Nov., 1958, pp. 45–58. In French. Description of the Bristol Britannia electric system, covering protective circuits, insulation, and warning systems.

Designing an Environmental Free Generator for Airborne Applications. E. Wharton. *Can. Aircraft Ind.*, Oct., 1958, pp. 6, 7, 45–47. Description of a generator in which the problems of supersonic cooling and high altitude brush wear are solved.

The Turbonator—An Integrated Air Turbine Generator for High Mach Aircraft. S. F. Richardson and J. W. Haynes. *SAE Natl. Aero. Meeting, Los Angeles, Sept. 29-Oct. 4, 1958, Preprint 94B.* 8 pp. Description of the turbonator and of the advantages it offers for future high-speed aircraft.

Hydraulic & Pneumatic

Aircraft Hydraulic Systems. *Sperry Rev.*, Summer, 1958, pp. 17–20. Discussion on the advantages and applications of hydraulic systems.

Fuels & Lubricants

The Future of Aircraft Fuels. R. J. Heaston. (*SAE Natl. Aero. Meeting, New York, Apr. 8–11, 1958.*) *Esso Air World*, July-Aug., 1958, pp. 7-9. Discussion of the criteria for fuel selection and evaluation. These include thermal stability, heating value, specific gravity, and reactivity.

The Relation of Fuels to Aircraft Turbine Engines. E. A. Droegemueller and R. K. Nelson. (*SAE Natl. Aero. Meeting, New York, Apr. 8–11, 1958.*) *Esso Air World*, May-June, 1958, pp. 147–152. Discussion of the methods for determining engine requirements and the necessary fuel characteristics.

The Control and Measurement of Cleanliness Quality in Turbo Fuel. C. E. Loeser, D. D. Love, and A. R. Ogston. (*SAE Natl. Aero. Meeting, Los Angeles, Sept. 29-Oct. 4, 1958, Preprint 89C.*) *Esso Air World*, Sept.-Oct., 1958, pp. 36–40.

Techniques for Surface Examination and Their Contribution to Our Knowledge of Friction and Wear. F. T. Barwell. *Lubrication Eng.*, Sept., 1958, pp. 391–397. 11 refs. Survey of the factors entering into the wear process, together with an analysis of the common machine elements.

Ball and Roller Bearing Lubrication. *Lubrication*, Aug., 1958. 12 pp. 32 refs.

Chemical Conversion Coatings for the Lubrication of Titanium. E. L. White and P. D. Miller. *Lubrication Eng.*, Nov., 1958, pp. 479–482.

Chemical Nature of Extreme Pressure Lubrication. George Hugel. *Lubrication Eng.*, Dec., 1958, pp. 523–526. Development of an organometallic complex to produce beneficial solid deposits on rubbing surfaces at points of high pressure and temperature.

Thermodynamic Charts for the Decomposition Products of 80, 85 and 90 per cent W/W Hydrogen Peroxide (H.T.P.) Appendix—Sources of Data and Method of Constructing the Charts. E. Carter. *Gt. Brit., RAE TN R.P.D. 161*, Apr., 1958. 12 pp.

La Pulvérisation des Carburants Liquides par Injection Centrifuge. R. Kling. *La Recherche Aéronautique*, Sept.–Oct., 1958, pp. 13–21. In French. Description of means for reducing the ignition delay of kerosene fuels.

The Gasification of Solid Ammonium Nitrate. W. H. Andersen, K. W. Bills, A. O. Dekker, E. Mishuck, G. Moe, and R. D. Schultz. *Jet Propulsion*, Dec., 1958, pp. 831, 832. USAF-supported investigation in which the surface of solid ammonium nitrate is heated at such a high rate of heat input that the surface gasifies at a rate which is greater than the bulk decomposition rate.

The Thermal Stability of Unsymmetrical Dimethylhydrazine. A. E. Spakowski. *U.S., NASA Memo. 12-13-58E*, Dec., 1958. 12 pp. Investigation of a static system simulating conditions in an almost empty fuel tank. The self-ignition temperature and spontaneous decomposition temperature of the pure fuel are determined at atmospheric pressure to be 454° and 740°F., with the larger value obtained in an inert atmosphere of nitrogen representing the minimum temperature that would cause a rapid exothermic reaction.

Ice Formation & Prevention

Ice on Aircraft. A. E. Knowler. *Shell Av. News*, Nov., 1958, pp. 14–17. Discussion of the

physical principles involved in ice formation, and of the research programs to overcome icing problems.

Electrical or Hot Gas Thermal Ice Protection. J. A. Hay. *SLAE J.*, Oct., 1958, pp. 3–9. Description of the two systems and comparison of each in terms of structural limitations, installation problems, weight, control of the system, aircraft performance penalty, and maintenance.

Prevention of Mist and Ice on Aircraft Windows. *Shell Av. News*, Sept., 1958, pp. 19, 20. Discussion of two methods of electric heating, one by means of a fine grid of resistance wires in the glass, and the other using a transparent conductive film of gold.

Instruments

Oscillographs in Dynamic Testing. F. A. Smith. *Mil. Electronics*, Dec., 1958, pp. 16–18. Discussion of the various applications of oscillographs in flight testing.

Ground Test Equipment for a Supersonic Aircraft Damper System. L. S. Ponzo and J. H. Gregson. *Can. Aircraft Ind.*, Oct., 1958, pp. 19–23, 51, 52.

Compact Microwave Refractometer for Use in Small Aircraft. M. C. Thompson, Jr., and M. J. Vetter. *Rev. Sci. Instr.*, Dec., 1958, pp. 1,093–1,096. Development of an instrument to make direct airborne measurements of radio refractive index of the atmosphere.

Masterminding Guided Missile Development. *CEC Recordings*, Fall, 1958, pp. 4–6. Description of the CEC mass spectrometer developed for flame research application.

Accelerometers

Results of Accelerometer Shaker Tests. M. I. Rothman. *USAF MDC TN 58-13 [AD 154102]*, Aug., 1958. 7 pp. Test results indicating that the performance of transducers tested only approximates that specified by the manufacturer. The great desirability of vibrational calibration of accelerometers just prior to use is clearly indicated.

B. T. Accelerometer Response Under Environmental Extremes. Aleck Goldberg. *Environmental Quart.*, 3rd Quart., 1958, pp. 4–6, 18. Test results from the calibration of barium titanate transducers.

Design of Accelerometers for Transient Measurements. Sheldon Rubin. (*ASME West Coast Conf., Los Angeles, Sept. 8, 9, 1958, Paper 58–APM-6.*) *J. Appl. Mech.*, Dec., 1958, pp. 509–514. 10 refs. Study made in order to find a significant accelerometer accuracy criterion for measuring transients and to apply it to the investigation of optimum damping and the range of frequency response required.

Flight Instruments

Kinalog; A New Approach to Blind-Flying Instrumentation. *Flight*, Nov. 28, 1958, pp. 823–825. Description of an attitude display system developed by Convair.

Flow Measuring Devices

A New Flow Meter. G. R. Brown and W. O. Weber. *Instrumentation*, May–June, 1958, pp. 12–15. Description of the design and development of a new bellows-type instrument for metering flow, liquid level, and differential pressure.

The Constant-Current Hot-Wire Anemometer in Subsonic Compressible Flows. Appendix I—Variation of Wire Resistance with Temperature. Appendix II—Linear Theory of Response of a Constant-Current Hot-Wire Anemometer to Fluctuations in Compressible Flows. Appendix III—Temperature Fluctuations Induced by Velocity Fluctuations Over a Cooler. D. I. Paddison. *Brown U. Div. Eng. (AFOSR TN 58-713) [AD 162248]*, Aug., 1958. 37 pp. Presentation of measurements of the heat-loss from a tungsten wire over a range of Mach Numbers from zero to 1.05 and Reynolds Numbers from one to 36.

Static Response of a Hemispherical-Headed Yawmeter at High Subsonic and Transonic Speeds. P. G. Hutton. *Gt. Brit., ARC CP 401* (Aug., 1957) 1958. 24 pp. BIS, New York, $0.63.

Pressure Measuring Devices

Standards in Pressure Measurement. R. J. Cartier. *Auto. Control*, Dec., 1958, pp. 12–15. (Also in *Instruments & Automation*, Dec., 1958, pp. 1,980, 1,981.) Description of manometric pressure measuring devices, the various sources of error, and the techniques used to reduce them to negligible values.

A Guide to Static-Pressure Transducers That Have Diaphragm, Bellows or Bourdon Pressure Cells. H. D. Nunn. *Prod. Eng.*, Jan. 5, 1959, pp. 48, 49.

Capteurs de Pression et Manomètres Miniatures Utilisables en Soufflerie et en Vol. M. Bassière. (*NATO AGARD Wind-Tunnel & Model-Testing Panel, London, Mar. 24–28, 1958.*) *NATO AGARD Rep. 173*, Mar., 1958. 18 pp. In French. Discussion of requirements for wind-tunnel and flight pressure measurements. A description is given of strain-gage miniature manometers, optical manometers, and telemetric manometers developed for this purpose.

Recording Manometer with Photoelectric Sensing of a Liquid Column. W. Wuest. *Aero. Versuchsanstalt, Göttingen, Bericht No. 58/A/03*, Feb. 14, 1958. 8 pp. Description of a manometer with photoelectric sensing of the liquid column and remote control of the recorder.

Pressure Probes Selected for Three-Dimensional Flow Measurement. D. W. Bryer, D. E. Walshe, and H. C. Garner. *Gt. Brit., ARC R&M 3037* (Nov., 1955) 1958. 26 pp. BIS, New York, $1.71. Results of tests on seven pressure probes in a uniform stream to ascertain the best types for measuring velocity and flow direction.

Recording Equipment

One Oscillograph Measured Ground Static and Airborne Tests. A. J. Wittenbach. *Can. Aircraft Ind.*, Oct., 1958, pp. 28, 29. Application of an oscillograph to the recording of strains and deflections on an airframe.

Temperature Measuring Devices

A Differential Thermal Analysis Apparatus. F. W. Wilburn. *J. Sci. Instr.*, Nov., 1958, pp. 403–407. Description of an instrument that measures continuously the difference between the sample and the inert reference material.

Pyromètre Infrarouge Destiné à la Mesure des Températures d'Ailettes de Turbine. J. Crabol and J. Van Kote. *La Recherche Aéronautique*, Sept.-Oct., 1958, pp. 3–11. In French. Description of a device for measuring in flight the temperatures generated on turbine blades. The test equipment and methods are described.

Laws & Regulations

Régime de Souveraineté de la Très Haute Atmosphère et Statut du Vaisseau de l'Espace. Edouard B.-Winandy. (*Congrès Internatl. Fusées & Engins-Guidés, Paris, Dec. 3–8, 1956*). *Fusées*, Apr., 1958, pp. 34–39. 15 refs. In French. Discussion of the legal aspects of space exploration.

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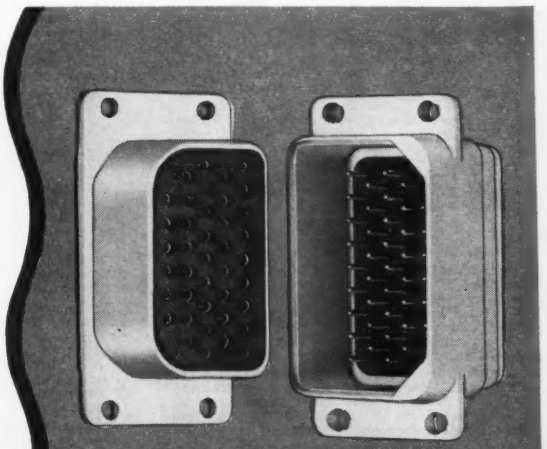

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Machine Elements

Bearings

Annual Report ONR Project A-2049. D. D. Fuller. *Franklin Inst. Labs. Interim Rep. I-A2049-3*, July 15, 1958. 25 pp. ONR-supported analytical and experimental investigation of the fundamental behavior of gas-lubricated bearings and establishment of general design criteria for these bearings.

A Study of the Stability of Externally Pressurized Gas Bearings. Appendix I—The Weighted Pressure Integral. Appendix II—A Simplified Stability Analysis. Lazar Licht and Harold Elrod. *Franklin Inst. Labs. Interim Rep. I-A2049-4*, Nov., 1958. 41 pp. Study in which the pertinent equations are linearized and the stability criteria stated in considering small deviations from the equilibrium point. The flow in the bearing clearance is treated on a distributed rather than a lumped parameter basis.

Rotating Discs & Shafts

The Torsion of Shafts of Varying Circular Cross Sections. H. L. Hunzeker. *U. Mich. Dept. Math. Rep.* (*AFOSR TN 58-738*) [*AD 201504*], Oct., 1958. 86 pp. 36 refs. Reduction of the fundamental equations of elasticity using a tensorial approach due to Hay. The torsion problem is studied for four specific cases.

Stresses in a Circular Disk with an Eccentric Circular Hole Under Radial Forces. Kazyu Miyao. *JSME Bul.*, Aug., 1958, pp. 195–198. Presentation of a theoretical solution, including derivation of formulas for the stress along the edge of circles and calculation of the stress distributions of the inner hole.

Tensioni Dovute alle Forze Centrifughe nei Volani a Razze. Giuseppe Manzella. *Tec. Ital.*, July-Aug., 1958, pp. 305–314. 10 refs. In Italian. Presentation of diagrams showing the stress distributions due to centrifugal forces acting on rotating discs determined photoelastically.

Transmissions, Clutches, Drives

Mechanical Consideration in the Design of a Constant Speed Transmission for Mach 3 Applications. D. L. Cauble, K. A. Teumer, and J. G. Castor. *SAE Natl. Aero. Meeting, Los Angeles, Sept. 29-Oct. 4, 1958, Preprint 94D.* 16 pp.

Constant Speed Drives for High Mach Aircraft. F. L. Moncher and J. S. Cardillo. *SAE Natl. Aero. Meeting, Los Angeles, Sept. 29-Oct. 4, 1958, Preprint 94C.* 22 pp. Description of the mechanical characteristics for the components utilized in hydraulic variable-speed transmissions, and discussion on some of the technical problems and their solutions in assembling these components into complete speed drive systems.

Adaptation of Constant Speed Drives to Long Range Manned Aircraft of the Immediate Future. C. W. Helsley, Jr. *SAE Natl. Aero. Meeting, Los Angeles, Sept. 29-Oct. 4, 1958, Preprint 94A.* 19 pp. Discussion of the rigorous conditions under which future constant speed drives must operate and evaluation of the ability of various types of drives to meet them.

Maintenance

Statistical Quality Control in Airline Maintenance. H. G. Packer. *Can. Aero. J.*, Dec., 1958, pp. 347–350. Discussion of some aspects of the application of statistical procedures to quality control. Reliability, probability, measurement variation, process control, and control limits are considered.

Keeping the Jet Transports Working. R. D. Kelly. *SAE Natl. Aero. Meeting, Los Angeles, Sept. 29-Oct. 4, 1958, Preprint 86A.* 10 pp. Discussion of the effects of payload, block speed, and utilization upon revenue capability.

Airline Planned Maintenance. R. J. McWilliams. (*CAI Mid-Season Meeting, Vancouver, Feb. 28, 1958.*) *Can. Aero. J.*, Sept., 1958, pp. 217–223. Discussion on the development of a system for flying and maintenance operations control and the achievement of greater economy of resources. The objectives are outlined and the systems and procedures developed to meet them are described.

Engine Mount: Inspection and Repair; DC-6 Series (R6D-1, C-118A) and DC-7 Series. *Douglas Serv.*, Nov.-Dec., 1958. 24 pp.

Materials

Ceramics & Ceramals

A Review of the Development of Cermets. G. C. Deutsch, A. J. Meyer, Jr., and G. M. Ault. (*NATO AGARD 7th Structures & Materials Panel, Rome, Mar. 24-Apr. 3, 1958.*) *NATO AGARD Rep. 185*, Mar.-Apr., 1958. 20 pp. 25 refs. Definition of cermet materials and discussion of the development of different varieties of cermets. Their physical and mechanical properties are considered, with particular reference to the poor impact strength and ductility. Ways of improving these two properties are examined.

Transition Layer is Key to Good Ceramic-to-Metal Bonds. G. R. Van Houten. *Materials in Des. Eng.*, Dec., 1958, pp. 112–114. 10 refs. Discussion of four processes used in metallizing ceramics.

A Guide to Ferroelectric Ceramics. George Economos. *Materials in Des. Eng.*, Dec., 1958, pp. 103–108.

Thermal Insulation Ceramic Coatings. A. V. Levy. (*CAI-IAS Joint Meeting, Ottawa, Oct. 7, 8, 1958, Preprint 857.*) *Can. Aero. J.*, Dec., 1958, pp. 343–346.

Corrosion & Protective Coatings

Aluminum Corrosion—An Unnecessary Evil. J. R. Beale. (*CAI Mid-Season Meeting, Vancouver, Feb. 28, 1958.*) *Can. Aero. J.*, Nov., 1958, pp. 322–326.

An Autocycling Process for Surface Treatment of Aluminum Components. C. J. Riddle. *Can. Aircraft Ind.*, Nov., 1958, pp. 13–15, 34–40. Description of a surface treatment approach, processing several times the number of parts handled by comparable methods. The steps required for the chemical treatment are outlined.

Three Ways to Avoid Corrosion in Magnesium. R. J. Fabian and John Stevens. *Materials in Des. Eng.*, Dec., 1958, pp. 109–111.

The Effect of Vapour Phase Inhibitors on the Corrosion of Metals. T. R. F. W. Fennell. *Gt. Brit., RAE TN Chem. 1328*, June, 1958. 11 pp.

Metals & Alloys

How to Evaluate Formability of Sheet Metal. D. A. Stewart. *Materials in Des. Eng.*, Dec., 1958, pp. 100–102.

O Roli Vneshnego Napriazheniia v Razuprochnenii pri Plasticheskoi Deformatsii. M. B. Makogon, V. E. Panin, V. F. Sukharov, L. P. Abramets, A. D. Korotaev, and N. A. Shcherbakova. *AN SSSR Dokl.*, Sept. 11, 1958, pp. 219–221. 14 refs. In Russian. Determination of the effect of external stress on the recovery of metals in the case of plastic deformation.

Diffuziia v Splavakh Sistemy Nikel'-Khrom-Vol'fram-Aliuminii-Titan. I. I. Kornilov and A. Ia. Shiniaev. *AN SSSR Otd. Tekh. Nauk Izv.*, Oct., 1958, pp. 96–99. In Russian. Results of diffusion experiments on quinary alloys (Ni-Cr-W-Al-Ti) in terms of density and temperature behavior.

O Razryve v Krivykh Ustalosti Diuraliumina. V. I. Shabalin. *AN SSSR Dokl.*, Oct. 1, 1958, pp. 600–602. In Russian. Investigation to determine the discontinuity in duralumin fatigue curves. Includes description of the test equipment and methods used.

Zakonomernosti Obrazovaniia Metastabil'nykh Faz v Splavakh na Osnove Titana. Iu. A. Bagariatskii, G. I. Nosova, and T. V. Tagunova. *AN SSSR Dokl.*, Oct. 1, 1958, pp. 597–599. In Russian. Establishment of laws of formation of the metastable phase in titanium alloys.

Fatigue and Ageing. F. Bollenrath. (*NATO AGARD 6th Structures & Materials Panel, Paris, Nov. 4-8, 1957.*) *NATO AGARD Rep. 157*, Nov., 1957. 18 pp. 14 refs. Discussion of the reciprocal influence of ageing and fatigue behavior. Reasons for ageing are discussed briefly, and results of different degrees of ageing for some aluminum alloys and a mild steel are given.

Fatigue of Structural Materials at High Temperatures. B. J. Lazan. (*NATO AGARD 6th Structures & Materials Panel, Paris, Nov. 4-9, 1957.*) *NATO AGARD Rep. 156*, Nov., 1957. 27 pp. 28 refs. Review of the general nature of fatigue at elevated temperature, with special emphasis on progressive fracture and statistical aspects.

Fatigue Strength of Induction-Hardened Test-Piece with Crack. Hiroshi Nakamura, Tatsuo Amakasu, and Shiro Ueda. *JSME Bul.*, Aug., 1958, pp. 227–232. Experimental investigation of the fatigue strength of carbon steel specimens containing 0.18%C. Some of the specimens were induction hardened, and the results were compared with those of ordinary plain specimens.

Fatigue Strength of Steel Specimens with Artificial Cracks. Hisashi Ouchida. *JSME Bul.*, Aug., 1958, pp. 233–239.

Die Ermüdungsfestigkeit des Schweissmetalls. Olavi Eiro. *Acta Polytechnica Scandinavica Me 3 (250)*, 1958. 26 pp. In German. Determination of the fatigue strength of welded metals subjected to dynamic loading.

Corrosion Sèche et Protection des Alliages Réfractaires Ni-Cr 80/20. M. Mathieu. (*NATO AGARD 6th Structures & Materials Panel, Paris, Nov. 4-8, 1957.*) *NATO AGARD Rep. 159*, Nov., 1957. 21 pp. 30 refs. In French. Study of the reasons for the failure of forged blades, considering the development of the intimate structure of the material under service conditions.

The Important Role of Nickel in Modern Aircraft Construction. *Can. Aircraft Ind.*, Oct., 1958, pp. 14, 15, 49–51.

Sintering of Multi-Phase Substances. IV—Sintering of Mixtures of High-Melting Metal Powders. B. Ia. Pines and A. F. Sirenko. *Sov. Phys.-Tech. Phys.*, Jan., 1958, pp. 131–139. Translation.

Martensitic Transformations and Determination of the Inhomogeneous Deformation. D. S. Lieberman. *Acta Metallurgica*, Nov., 1958, pp. 680–693. 25 refs. USAF-supported presentation of a simple graphical method for determining directly from observations of the crystallographic features of a martensitic transformation, the inhomogeneous deformation which is part of the total transformation distortion.

Metals & Alloys, Nonferrous

Progress in the Newer Metals. B. W. Gonser. *Battelle Tech. Rev.*, Dec., 1958, pp. 9–14. Discussion of the abundance, price, and ease of production for the rarer forms of metallic elements.

Condizioni nelle Quali le Travi Compresse in Lega di Magnesio Risultano Più Leggere o Più Resistenti di Quelle in Lega di Alluminio. Claudio Buda. *Tec. Ital.*, July-Aug., 1958, pp. 315–322. 15 refs. In Italian. Comparative determination of magnesium and aluminum alloy properties in terms of weight and strength characteristics.

The Strength in Compression and Tension of an Aluminium Alloy Extruded Angle to Specification D. T. D. 683A. Appendix I—Extracts from Specification D. T. D. 683A. Appendix II—Details of Material Used in Test. D. F. Wright. *Gt. Brit., RAE TN Struc. 246*, July, 1958. 18 pp.

Properties of a Large Extrusion Supplied to Specification D. T. D. 363. T. R. G. William, S. W. Hallwood, and R. W. Hayden. *Metallurgia*, Nov., 1958, pp. 219–224. Results from static and fatigue testing of an Al-Zn-Mg-Cu alloy. Longitudinal test pieces taken from the center of the extruded section show a lower tensile strength than those located nearer the surface.

Strength of Metal-Arc Welds in HP.30 Aluminium Alloy; Effect of Porosity and Weld Shape. D. F. Adams. *Brit. Welding J.*, Dec., 1958, pp. 568–575.

La Progettazione di Strutture in Magnesio. Claudio Buda. *Tec. Ital.*, Apr.-May, 1958, pp. 169–176. In Italian. Determination of properties for magnesium and its alloys and comparison to other materials.

Nonmetallic Materials

Aircraft Timber. III—Selection and Seasoning of Aircraft Timber. IV—The Testing of Aircraft Timbers. D. W. Richardson. *SLAE J.*, Oct.; Nov., 1958, pp. 10–19; 7, 8.

Impact Sensitivity of Organic Materials on Exposure to Liquid Oxygen. D. E. Clippinger and G. J. Morris. *Martin Rel. No. 2496*, 1958. 17 pp. Discussion of testing methods to determine what organic materials become explosively sensitive when in contact with liquid oxygen.

Polyurethane Elastomer. *Aircraft & Missiles Mfg.*, Dec., 1958, pp. 38, 39. Discussion of the mechanical properties, application, and availability of polyurethane elastomers.

Evaluation of an Epoxy-Polyamide Adhesive for Metal. M. J. Gregory and M. G. D. Hockney. *Gt. Brit., RAE TN Chem. 1329*, June, 1958. 21 pp.

Elastic Properties of Orthogonally Woven Structure. Shin Owada. *Japan Soc. Aero. Eng. Trans.*, No. 1, 1958, pp. 19–25. Calculations of elastic properties and measurements on a model structure for metallic nets and other cloths having typical orthogonal anisotropy and perfect nonrigidity against tangential loads.

On the Strength of the Glass Fiber Reinforced Polyester—Damage of the Glass-Cloth by Pressing and Influence of Moisture and Dryness. Shigehisa Otsuki. *JSME Bul.*, Aug., 1958, pp. 244–250.

Literatuurstudie Over de Mechanische Eigenschappen van Glasvezel-Kunstharsmaterial. A. Hartman. *Netherlands, NLL TM M. 2026*, Mar., 1957. 115 refs. In Dutch. Review of the literature on glass laminates to determine the various factors influencing mechanical properties.

The Use of Plastics at High Temperatures. I. J. Gruntfest. *SAE Natl. Aero. Meeting, Los Angeles, Sept. 29-Oct. 4, 1958, Preprint 82A.* 8 pp. Analysis of the possible applicability of organic plastics for the skins of hypersonic vehicles. Chemical and physical properties are considered.

Tailoring Polymers for Electronics. Ch. L. Petze, Jr. *SPE J.*, Dec., 1958, pp. 35–39. Discussion covering silicone alloys formulated to meet specific dielectric and insulating properties.

How Plastics React Under Rapid Loading. G. R. Rugger, E. McAbee, and M. Chmura. *SPE J.*, Dec., 1958, pp. 31–34. Presentation of data on high loading rates from 5–15 milliseconds.

The Behavior of Polymethyl Methacrylate Under Repeated Load. F. G. Lewis. *Australia, ARL Note Met. 10*, July, 1958. 26 pp. 23 refs.

New Foamed Silicones Give Hi-Temp Insulation. D. E. Weyer. *Prod. Eng.*, Jan. 5, 1959, p. 50. Presentation of data on the latest rigid, semirigid, and flexible self-curing silicones.

The Dynamic Compression of Perspex. J. S. Buchanan, H. J. James, and G. W. Teague. *Philos. Mag., 8th Ser.*, Dec., 1958, pp. 1,432–1,448. 16 refs. Experimental investigation to measure the velocity of propagation of a shock wave passing through Perspex and the velocity of the free surface caused by the normal reflection of the shock wave at the Perspex-air boundary. The Hugoniot equation of state is determined within the pressure range from 3 to 3 × 10^{10} dynes cm.$^{-2}$.

Dynamic Properties of BTR Elastomer. G. W. Painter. *SAE Natl. Aero. Meeting, Los Angeles, Sept. 29-Oct. 4, 1958, Preprint 83B.* 18 pp. Description of a new technique for measuring the components of the dynamic modulus of elastomers, and presentation of the dynamic properties of BTR under various environmental conditions.

Elastomers for High Temperature Applications. E. R. Bartholomew. *(NATO AGARD 7th Structures & Materials Panel, Rome, Mar. 24-Apr. 3, 1958.) NATO AGARD Rep. 178*, Mar.-Apr., 1958. 23 pp. Discussion of the nature of high-temperature elastomer problems and the limitations of the more conventional elastomer materials. Recent data on properties of special high-temperature polymers and their compounds are included.

Testing Methods

The Measurement of the Strain-Dependent Damping of Metals Vibrating Torsionally. G. Sumner and K. M. Entwistle. *Brit. J. Appl. Phys.*, Nov., 1958, pp. 434–438.

Physical Properties of Plastics for Photothermoelastic Investigations. H. Tramposch and G. Gerard. *(ASME West Coast Conf., Los Angeles, Sept. 8, 9, 1958, Paper 58-APM-2.) J. Appl. Mech.*, Dec., 1958, pp. 525–528.

Experimental Determination by an Optical Method of the Stresses in an Anisotropic Plate Under the Action of a Concentrated Force. II. V. M. Krasnov, A. V. Stepanov, and E. F. Shvedko. *(Zhurnal Teoret. i Exper. Fiz.*, Apr., 1958, pp. 894–898.) *Sov. Phys.-JETP*, Oct., 1958, pp. 619–622. Translation.

Mathematics

The Solution of Cubic Equations by Iteration. W. A. Coppel. *ZAMP*, Nov. 25, 1958, pp. 380–383.

O Sposobe Vvedeniia Malogo Parametra v Urvavneniia Nelineinykh Kolebanii. A. P. Proskuriakov. *Prikl. Mat. i Mekh.*, Sept.-Oct., 1958, pp. 711–713. In Russian. Derivation of a method for introducing a small parameter into the equations of nonlinear oscillation.

Priblizhennyi Metod Resheniia Granichnykh Zadach dlia Nekotorykh Uravnenii Ellipticheskogo Tipa. I. A. Kunin. *AN SSSR Otd. Tekh. Nauk Izv.*, Oct., 1958, pp. 146–150. In Russian. Development of an approximate method to solve the boundary problems for certain equations of the elliptic type.

O Chisle Reshenii Odnorodnogo Singuliarnogo Integral'nogo Uravneniia s Nepreryvnymi Koeffitsientami. I. Ts. Gokhberg. *AN SSSR Dokl.*, Sept. 21, 1958, pp. 327–330. In Russian. Analysis of the number of solutions of a homogeneous singular integral equation with continuous coefficients.

Proposed Methods for the Analog Solution of Fredholm's Integral Equation. M. E. Fisher. *Assoc. Comp. Mach. J.*, Oct., 1958, pp. 357–369. 20 refs.

Issledovanie Odnoi Zadachi s Kosoi Proizvodnoi pri Pomoshchi Sistemy Uravnenii Fredgol'ma. I. I. Daniliuk. *AN SSSR Dokl.*, Sept. 11, 1958, pp. 175–178. In Russian. Application of the Fredholm system of equations to study a problem involving a skew derivative.

Nekorrektnost' Zadachi Dirikhle dlia Uravnenii Smeshannogo Tipa v Smeshannykh Oblastiakh. A. V. Bitsadze. *AN SSSR Dokl.*, Sept. 11, 1958, pp. 167–170. In Russian. Evaluation of the Dirichlet problem and determination of its incorrectness for the mixed type of equations in mixed regions.

Ob Uravnenii Beskonechnogo Poriadka s Polinomial'nymi Koeffitsientami. Iu. F. Korobeinik. *AN SSSR Dokl.*, Sept. 21, 1958, pp. 339–342. In Russian. Derivation of a solution for the equations of infinite order with polynomial coefficients.

Some More Theorems Concerning the Absolute Summability of Fourier Series and Power Series. T. M. Flett. *London Math. Soc. Proc., 3rd Ser.*, July, 1958, pp. 357–387. 24 refs.

O Zadache Koshi dlia Kvazilineinykh Uravnenii. B. L. Rozhdestvenskii. *AN SSSR Dokl.*, Oct. 1, 1958, pp. 551–554. In Russian. Derivation of a method used to reduce the uniqueness problem of a generalized solution of the Cauchy problem for a system of quasilinear equations to that of uniqueness of a continuous solution for a certain system of nonlinear equations.

Remarks on the Disposition of Points in Numerical Integration Formulas. A. H. Stroud. *Math. Tables & Aids to Comp.*, Oct., 1957, pp. 257–261.

Numerical Integration Over the Spherical Shell. W. H. Peirce. *Math. Tables & Aids to Comp.*, Oct., 1957, pp. 244–249. 13 refs.

Dostatochnoe Uslovie Skhodimosti Metoda Osredneniia Funktsional'nykh Popravok. A. Iu. Luchka. *AN SSSR Dokl.*, Sept. 11, 1958, pp. 179–182. In Russian. Derivation of a sufficient condition for the convergence of the procedure for averaging functional corrections.

Interpretiag Straight Liae Relationships. G. L. Burrows. *Ind. Quality Control*, Oct., 1958, pp. 15–18. Application of the method of least squares to the solution of linear problems.

Numerical Experiments in Potential Theory Using the Nehari Estimates. U. W. Hochstrasser. *Math. Tables & Aids to Comp.*, Jan., 1958, pp. 26–33. AFOSR-sponsored study of the error introduced by replacing infinite orthogonal expansions by finite ones.

Characteristic Properties of Algebraic Surfaces and Determination of the Factors of Polynomials. Li Shiang-Ping. *Scientia Sinica*, Oct., 1958, pp. 1,001–1,026.

O Reguliarnosti Vypuklykh Poverkhnostei s Reguliarnoi Metrikoi v Prostranstvakh Postoiannoi Krivizny. A. V. Pogorelov. *AN SSSR Dokl.*, Sept. 11, 1958, pp. 186, 187. In Russian. Determination of the regularity of convex surfaces with a regular metric in spaces of constant curvature.

Nekotorye Voprosy Beskonechno Malykh Izgibanii Poverkhnostei. Sun' Khe-Shen. *AN SSSR Dokl.*, Oct. 1, 1958, pp. 559–561. In Russian. Study of certain problems of infinitesimal flexures of surfaces.

A Smoothest Curve Approximation. J. C. Holladay. *Math. Tables & Aids to Comp.*, Oct., 1957, pp. 233–243. Study of an integration rule based on the integration of a function passing through a given set of points such that the function will have a small amount of twisting, and such that whatever twisting is necessary will be spread out.

Obshchee Predstavlenie Reshenii Ellipticheskoi Sistemy 2*n* Uravnenii na Ploskosti. B. V. Boiarskii. *AN SSSR Dokl.*, Oct. 1, 1958, pp. 543–546. In Russian. General representation of the solutions of an elliptical system of 2*n* equations on a plane.

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Dokazatel'stvo Teoremy o Gomeomorfizme Poliedrov i Tochechnykh Mnozhestv. I. Shvedov. *AN SSSR Dokl.*, Oct. 1, 1958, pp. 566–569. In Russian. Presentation of a proof of the homeomorphism of polyhedra and point sets.

Homology Operations. I. Yo Ging-Tzung. *Sci. Rec.*, Oct., 1958, pp. 332–337.

A Subgroup of the Orthogonal Group with Respect to an Indefinite Quadratic Form. Hua Loo-Keng. *Sci. Rec.*, Oct., 1958, pp. 329–331.

Linear Least-Squares Smoothing and Prediction, with Applications. Sidney Darlington. *Bell System Tech. J.*, Sept., 1958, pp. 1,221–1,294. 28 refs. Calculation of smoothing and prediction operators of the linear least-squares sort using techniques derived from a circuit theory point of view.

On Stability of a Randomized Linear System. O. Šefl. *Scientia Sinica*, Oct., 1958, pp. 1,027–1,034. Analysis considering the probability of stability in a system whose parameters are random variables.

Ob Ustoichivosti Trivial'nogo Resheniia Lineinykh Sistem s Periodicheskimi Koeffitsientami V. M. Starzhinskii. *Prikl. Mat. i Mekh.*, Sept.-Oct., 1958, pp. 646–656. 12 refs. In Russian. Determination of the stability of a trivial solution for linear systems with periodic coefficients.

A Method for Exact Determination of the Coefficients of a Linear System. G. M. Schindler. *USAF MDC TN 58-14 [AD 154103]*, Aug., 1958. 12 pp. Application of a suitable delta-DIRAC disturbance to a first-order linear system in order to find the system's coefficients.

Some Contributions to the Theory of One-Dimensional Local Rings. D. G. Northcott. *London Math. Soc. Proc., 3rd Ser.*, July, 1958, pp. 388–415. 12 refs. Extension of previous work by the geometric theory of infinitely near points and their proximity relations, as developed for curves in n-dimensional space.

O Nekotorykh Funktsional'nykh Prostranstvakh i ikh Prilozheniiakh k Variatsionnym Zadacham. I. V. Gel'man. *AN SSSR Dokl.*, Oct. 1, 1958, pp. 547–550. In Russian. Analysis covering some functional spaces and their application to variational problems.

Metoda Coordonatelor Vectoriale Cilindrice in Prezentarea Grafică a Algebrei Vectoriale Spațiale. N. Irimiciuc. *Iași Politeh. Inst. Bul.*, Fasc. 3/4, 1957, pp. 195–200. In Rumanian, with summaries in Russian and French. Development of a method for the graphical representation of problems including the reduction of spatial vector systems, based on the concept of cylindrical vector coordinates.

On a Theorem for the Uniform Spaces. Wang Shu-Tang. *Sci. Rec.*, Oct., 1958, pp. 338–342.

O Nekotorykh Tipakh Odnorodnykh Rimanovykh Prostranstv. Gu Chao-Khao. *AN SSSR Dokl.*, Sept. 11, 1958, pp. 171–174. In Russian. Analysis of certain types of homogeneous Rieman spaces.

Some Compact Solvmanifolds and Locally Affine Spaces. Louis Auslander. *J. Math. & Mech.*, Nov., 1958, pp. 963–975. Study of the existence of nilpotent Lie groups such that the homogeneous space is compact.

Stability Criteria for Systems Having Complex-Coefficient Polynomial Characteristic Equations. L. G. Kaufman, II. *J. Aero/Space Sci.*, Feb., 1958, pp. 122, 123.

Coefficients and Roots of the Polynomials Which Define the Derivatives of the Exponential of $(=\epsilon/T)$. E. S. Campbell, E. M. Fishbach, and J. O. Hirschfelder. *Maht. Tables & Aids to Comp.*, Jan., 1958, pp. 1–17.

The Dual Simplex Algorithm for Bounded Variables. H. M. Wagner. *Nav. Res. Logistics Quart.*, Sept., 1958, pp. 257–261. 14 refs. Study showing that Lemke's dual simplex algorithm can be extended to an m equation with bounded variables.

Gomologicheskie Svoistva Proobrazov Tochek pri Otobrazheniiakh Mnogoobrazii, Povyshaiushchikh Razmernost'. R. L. Frum-Ketkov. *AN SSSR Dokl.*, Sept. 21, 1958, pp. 349–351. In Russian. Determination of homologous properties of original point images in the case of manifold, dimension-increasing mappings.

Klassy Nasyshcheniia dlia Nekotorykh Protsessov Summirovaniia. F. I. Kharshiladze. *AN SSSR Dokl.*, Sept. 21, 1958, pp. 352–355. In Russian. Determination of saturation classes for some summation processes.

Continuation of Biharmonic Functions Across Circular Arcs. J. H. Bramble. *J. Math. & Mech.*, Nov., 1958, pp. 905–924. 33 refs. AFOSR-supported establishment of certain reflection principles (analogous to the classical Schwarz reflection principle for harmonic functions) for biharmonic functions subject to various boundary conditions.

The Kernel-Function and Conformal Invariants. Bernard Epstein. *J. Math. & Mech.*, Nov., 1958, pp. 925–936. Application to the theory of conformal mapping of certain invariants which are closely related to the Bergman kernel-function.

Certain Two-Dimensional Solutions to Poisson's Equation. G. Power and H. L. W. Jackson. *Appl. Sci. Res., Sect. B*, No. 4, 1958, pp. 249–256. Presentation of a method which derives the solution to Poisson's equation in two dimensions, subject to boundary conditions of sufficient generality to be applicable to many branches of mathematical physics.

On the Solution of Poisson's Difference Equation. Pentti Laasonen. *Assoc. Comp. Mach. J.*, Oct., 1958, pp. 370–382. ONR-sponsored analysis.

Complex Variable Applications to Certain Coupled Systems. D. P. Jenkins. *Gt. Brit., ARC CP 393* (Feb., 1957) 1958. 15 pp. BIS, New York, $0.45. Analysis showing that the solutions of similar differential equations which are coupled together can be expressed in terms of the solutions of a single differential equation, possibly containing complex parameters, but of the same order as each separate equation. Implications of this result are discussed, and Nyquist's criterion is generalized to study the stability of constant parameter systems of this type.

On the Use of Spectral Densities in the Study of Servo Circuits Defined by Linear Differential Equations with Time-Variable Coefficients and Stochastic Right Member. M. Sundström and K. Flodin. *KTH Aero. TN 44*, May 15, 1957. 9 pp.

A Method for Integrating a Set of Ordinary Differential Equations Subject to a Type of Numerical Indeterminacy. E. S. Campbell. *Math. Tables & Aids to Comp.*, Oct., 1957, pp. 229–233.

On the Accuracy of Implicit Difference Approximations to the Equation of Heat Flow. Wolfgang Wasow. *Math. Tables & Aids to Comp.*, Jan., 1958, pp. 43–55. Army-sponsored study of the convergence, stability, and truncation error of implicit difference approximations.

An Open Formula for the Numerical Integration of First Order Differential Equations. II. H. S. Wilf. *Math. Tables & Aids to Comp.*, Jan., 1958, pp. 55–58.

Ob Odnom Svoistve Kharakteristicheskikh Chisel Reshenii Differentsial'nykh Uravnenii. G. K. Pozharskii. *Prikl. Mat. i Mekh.*, Sept.-Oct., 1958, pp. 707–710. In Russian. Evaluation of a specific property of characteristic values in the solution of differential equations.

Asimptoticheskoe Integrirovanie Differentsial'nykh Uravnenii v Chastnykh Proizvodnykh s Kraevymi Usloviiami, Zavisiashchimi ot Parametra. A. L. Gol'denveizer. *Prikl. Mat. i Mekh.*, Sept.-Oct., 1958, pp. 657–672. In Russian. Asymptotic integration of partial differential equations with boundary conditions depending upon the parameter.

Note on the Computation of the Zeros of Functions Satisfying a Second Order Differential Equation. D. J. Hofsommer. *Math. Tables & Aids to Comp.*, Jan., 1958, pp. 58–60.

On Asymptotic Numerical Methods for Parabolic Equations. J. R. M. Radok. *Polytech. Inst. Bklyn., Dept. Aero. Eng. & Appl. Mech., PIBAL Rep. 485 (AFOSR TN 58-1072) [AD 207241]*, Nov., 1958. 14 pp. Study of the physical significance of the formal difference approach and application of the method to the numerical solution of parabolic differential equations.

Ob Odnorodnykh Raznostnykh Skhemakh. A. N. Tikhonov and A. A. Samarskii. *AN SSSR Dokl.*, Oct. 1, 1958. pp. 562–565. In Russian. Further development of the analysis performed to determine the difference schemes used in the uniform solution of differential equations for a wider class of coefficients.

O Smeshannykh Zadachakh dlia Uravnenii v Chastnykh Proizvodnykh s Dvumia Nezavisimymi Peremennymi. S. L. Sobolev. *AN SSSR Dokl.*, Oct. 1, 1958, pp. 555–558. In Russian. Analysis covering mixed problems for partial differential equations with two independent variables.

Interpolation Problems for Functions of Several Complex Variables. George Springer. *J. Math. & Mech.*, Nov., 1958, pp. 957–962.

A Class of Quasi-Pseudo-Conformal Transformations in the Theory of Functions of Two Complex Variables. Stefan Bergman. *J. Math. & Mech.*, Nov., 1958, pp. 937–956. 22 refs.

Ob Odnoi Zadache Ravnomernogo Raspredeleniia Sistemy Funktsii. A. M. Polosuev. *AN SSSR Dokl.*, Sept. 21, 1958, pp. 346–348. In Russian. Generalization of problems covering the uniform distribution of a system of functions.

O Predstavlenii Lineinykh Funktsionalov v Klasse Razryvnykh Funktsii. A. N. Tikhonov and A. A. Samarskii. *AN SSSR Dokl.*, Sept. 11, 1958, pp. 188–191. In Russian. Representation of linear functionals in the class of discontinuous functions.

Bessel Functions for Large Arguments. M. Goldstein and R. M. Thaler. *Math. Tables & Aids to Comp.*, Jan., 1958, pp. 18–26. Presentation of a method for defining two auxiliary functions—the amplitude and phase functions—in terms of the regular and irregular solution of Bessel's equation.

Complete Continuity Conditions on Linear Operators. J. R. Ringrose. *London Math. Soc. Proc., 3rd Ser.*, July, 1958, pp. 343–356. 11 refs.

The Evaluation of Matrix Elements in Functional Integral Form. J. L. Martin. *Royal Soc. (London) Proc., Ser. A*, Dec. 9, 1958, pp. 560–567. Application of the source-function technique of Schwinger to express any transformation matrix element in a form involving a functional derivative operator.

Calculation of Higher Transitions in a Markov Process. William Miehle. *Oper. Res.*, Sept.-Oct., 1958, pp. 693–698. Presentation of a new matrix method for calculating both first arrival probabilities and multiplicities of first arrival paths. The matrix method is suitable for enumerating paths and obtaining the diameter of a graph.

Mechanics

O Chastnykh Sluchiakh Dvizheniia Tiazhelogo Tverdogo Tela Vokrug Nepodvizhnoi Tochki. A. A. Bogoiavlenskii. *Prikl. Mat. i Mekh.*, Sept.-Oct., 1958, pp. 622–645. 34 refs. In Russian. Study covering several aspects of the problem of motion of a heavy solid body about a fixed point. Includes a survey of previously developed theories.

Meteorology

Meteorological Measurements in Jet Aircraft. R. J. Murgatroyd. *Shell Av. News*, Oct., 1958, pp. 7–11. Description of equipment and methods used in measuring temperature, wind velocity, and water vapor in altitudes between 45,000 and 60,000 ft.

Some Thermal Aspects of the Design of Heated Probes for Measuring Cloud Water Content. Appendix A—The Energy Balance for the Heated Wire Water Content Meter. Appendix B—Probable Error in Calculated Value of Water Content. D. C. Baxter. *Canada, NAE LR 72A*, Aug., 1958. 36 pp. Analysis considering the performance of a heated wire in measuring free water content, and illustration of the effect of various operating parameters.

The Spectrum of Vertical Velocity Near the Surface. H. A. Panofsky and R. A. McCormick. *IAS 27th Annual Meeting, New York, Jan. 26–29, 1959, Rep. 59–6.* 7 pp. Members, $0.50; nonmembers, $1.00. Presentation of spectra of time series of vertical velocity components. Shape, magnitude, and estimation of the spectra are considered.

Time Constant of a Monoplane Wind Vane of Which the Moment of Inertia and Arm Length Are Systematically Changed. M. Sanuki, S. Kimura, and H. Kato. *Papers in Meteorology & Geophys.*, Oct., 1957, pp. 232–235.

A Pneumatically Actuated Icing Detector for Stationary Operation. R. C. Goettelman and I. G. Poppoff. *AMS Bul.*, Nov., 1958, pp. 565–568. Description of an icing detector operating on a pressurized air system and utilizing the pressure drop produced accross a Venturi tube as an indication of icing conditions.

La Topografia delle Nubi. Nicola Morasca. *Riv. Meteorologia Aero.*, Oct.-Dec., 1958, pp. 20–25. In Italian. Study and development of a simplified photogrammetric method for determining the position, size, and height of clouds, in particular, cumulonimbus.

Atmospheric Structure & Physics

Doppler Radar and the Tornado Problem. F. S. Wood. *Res. Trends (Cornell Aero. Lab.)*, Fall, 1958, pp. 5–7. Discussion of a research program on controlling contrails, measuring droplet size, and dissipating clouds.

An Analysis of Routine 300-mb. Transosonde Flights from Japan. J. K. Angell. *Mo. Weather Rev.*, Sept., 1958, pp. 335–343. Presentation of statistics on the wind velocity, acceleration, and power spectra for the flights.

Upper Air Research

On the Production of Radioisotopes in the Atmosphere by Cosmic Radiation and Their Application to Meteorology. D. Lal, P. K. Malhotra, and B. Peters. *J. Atmos. & Terrestrial Phys.*, July, 1958, pp. 306–328. 54 refs. Calculation and graphical representation of the production rates of various radioisotopes for all parts of the atmosphere. The dependence of the relative concentrations of isotopes on latitude and altitude and their usefulness are shown.

Satélites Artificiales y Meteorología. R. C. Robles. *Rev. Aero.*, Aug., 1958, pp. 611–619. In Spanish. Discussion covering the use of satellite observations in weather analysis and forecasting.

I Satelliti Artificiali e la Meteorologia. R. Bilancini. *Riv. Meteorologia Aero.*, Oct.-Dec., 1958, pp. 35–37. In Italian. Discussion of the use of satellite observations in meteorological research.

Meteorological Rocket Soundings in the Arctic. W. G. Stroud. *(ARS Semi-Annual Meeting, Los Angeles, June 9–12, 1958.) Jet Propulsion*, Dec., 1958, pp. 817–822. 16 refs. Description of the rocket-firing program and presentation of some results.

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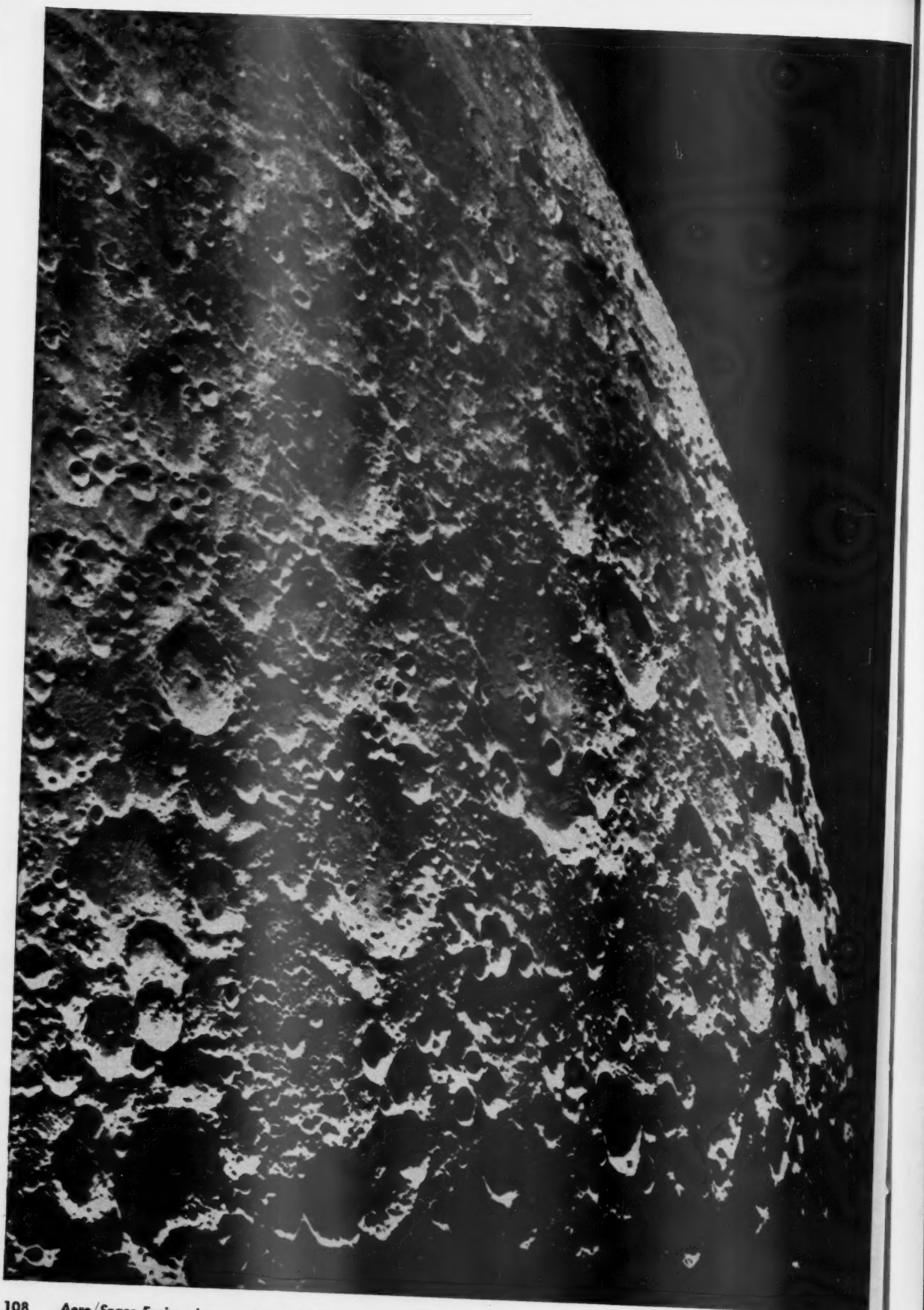

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Atmospheric Soundings in Arctic Use Proven Rocket Techniques. *Aircraft & Missiles Mfg.*, Dec., 1958, pp. 44–47. Description of experiments and techniques used to measure temperature, pressure, density, and winds at high altitude in the Arctic. Methods used in USSR are briefly discussed.

Missiles, Rockets

Project Vanguard—A Report on Progress. H. Cohen. *Ind. Quality Control*, Nov., 1958, pp. 8–11. Description of the flight-test program, including the launching vehicle and the results of five firings.

Les Engins Américains. J. Klopp. *Docaéro*, Nov., 1958, pp. 3–30. In French. Survey of missile research in the USA, including research facilities, programs, various participating industries, characteristics of missile types, and propulsion systems.

Oblateness Correction to Impact Points of Ballistic Rockets. R. E. Roberson. (*ARS 12th Annual Meeting, New York, Dec. 2–5, 1957.*) *Franklin Inst. J.*, Dec., 1958, pp. 465–481. Study in which suitable descriptive variables are chosen so that the oblateness perturbations can be obtained by quadrature. Explicit results are obtained correct to first order in an oblateness parameter, specifically, changes in range angle, a lateral displacement angle, and time of flight.

Some Comments on Generalized Trajectories for Free Falling Bodies of High Drag. William Squire. *Jet Propulsion*, Dec., 1958, pp. 838, 839.

Calculation of Re-Entry Velocity Profile. A. A. Adler. *Jet Propulsion*, Dec., 1958, pp. 827, 828. Presentation of an improved equation to calculate the velocity versus altitude profile of a ballistic missile re-entering the earth's atmosphere.

Missiles 1958. *Flight*, Dec. 5, 1958, pp. 873–898. Appraisal of the world's guided weapons and of unguided missiles of particular interest. Development, design, and performance characteristics are described.

Guided Weapons. *Sperry Rev.*, Summer, 1958, pp. 21–26. Discussion of design considerations and manufacturing techniques in guided missile development.

Atlas. Roger Fischer and C. J. Mundo. *ARMA Eng.*, Oct.-Nov., 1958, pp. 4–7. Discussion of design development and description of propulsion and guidance systems.

Thor: A Study of a Great Weapon System. *Flight*, Dec. 5, 1958, pp. 862–872. Review of the historical background, and detailed description of the airframe, propulsion, guidance systems, nose-cone, and warhead. The ground-support equipment and launching procedures are also described.

Minuteman: Some Unclassified Characteristics Analyzed. Eric Burgess. *Missile Des. & Devel.*, Dec., 1958, pp. 12–14. Discussion of the deterrent possibilities of the solid-propellant missile. The reliability of the system, the checkout, and servicing are considered.

Solid-Propellant Rockets and Space Flight. K. R. Stehling. *Interavia*, Nov., 1958, pp. 1,205–1,207. Discussion of the reasons leading to the choice of solid propellants in rocketry. Their advantages and limitations are also evaluated.

Missile Guidance—A Decade of Progress. R. C. Gibson. *Holloman Mo. News Bul.*, Oct., 1958, pp. 6, 7, 10. Review of the development of guidance systems including radio-radar and inertial systems.

Le Guidage des Engins. P. C. Gaudillère. *Fusées*, Apr., 1958, pp. 26–28. In French. Survey covering various missile guidance techniques.

Formula for Inertial Guidance Gyro Evaluation. Aaron Becker. *ARMA Eng.*, Oct.-Nov., 1958, pp. 20–24. Description of the laboratory installation, and discussion of the gyro drift problem and its measurement.

Aided Inertial Systems. C. J. Mundo. *ARMA Eng.*, Oct.-Nov., 1958, pp. 15–19. Examination of the behavior of inertial navigators. An understanding of their specific limitations is derived, and a method for the optimization of combination systems, both linear and nonlinear, is outlined.

Inertial Navigation. Ted Newman. *ARMA Eng.*, Oct.-Nov., 1958, pp. 8–14. Examination of inertial navigation from the standpoint of the basic physical principles applied. The role of gyros and accelerometers in the overall system is emphasized.

Instruments: Key to Missile Programs. Frank Leary. *Electronics*, Jan. 16, 1959, pp. 47–51. Discussion on the operation of various missile data recording and processing systems. The role of electronics is stressed.

Special Issue: Advancing the Technology of Missile Instrumentation. *ISA J.*, Nov., 1958, pp. 50–113. 125 refs. *Partial Contents:* Instrumentation Aspects of Inertial Guidance, C. S. Draper. Laboratory Studies of Missile Re-Entry Aero-Thermodynamics, D. Bershader. Shock Tube Research in Hypersonic Aerodynamics, P. H. Rose. Pressure Transducers for Missile Testing and Control, Yao Tzu Li. Evolution of Test-Range Instrumentation, J. W. Muehlner. Measurements of Rocket Exhaust-Gas Temperatures, I. Warshawsky. Calibration of

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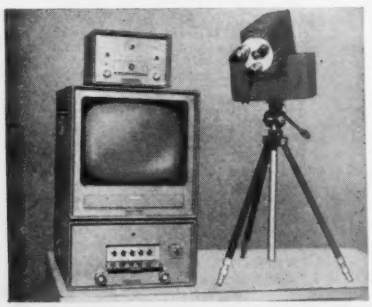

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A New Instrument for Measuring Atmospheric Density and Temperature at Satellite Altitudes. A. J. Dessler, W. B. Hanson, M. Hertzberg, D. D. McKibbin, and R. C. Wrigley. *Jet Propulsion*, Dec., 1958, pp. 837, 838.

Reentry Data Capsule. J. P. Kushnerick. *Aircraft & Missiles Mfg.*, Dec., 1958, pp. 22–25. Brief description of the Datasphere, including manufacturing details and data recovery problems.

Nike Hydro-Mechanical Maintenance Problems. H. J. Ide. *SAE Natl. Aero. Meeting, Los Angeles, Sept. 29-Oct. 4, 1958, Preprint 93B.* 6 pp.

Maintainability of the Falcon Missile System. R. W. Manley. *SAE Natl. Aero. Meeting, Los Angeles, Sept. 29-Oct. 4, 1958, Preprint 93C.* 9 pp.

Optimum Thrust Programming Along Arbitrarily Inclined Rectilinear Paths. A. Miele and C. R. Cavoti. (*Purdue U. Sch. Aero. Eng. Rep. A-57-8*, Dec., 1957.) *Astronautica Acta*, Fasc. 3, 1958, pp. 167–181. AFOSR-supported research.

Navigation

Polar Route Navigation. E. S. Pedersen. (*Inst. Navigation 14th Annual Meeting, Santa Barbara, June 19–21, 1958.*) *Navigation*; Summer, 1958, pp. 79–85. Discussion of the problems encountered and the navigation aids and systems used in polar navigation. The geography of the polar route is described.

Antarctica. J. L. B. Cowan. *Navigation*, Summer, 1958, pp. 89–94. Discussion of problems brought forth by long-range nonstop flights over polar areas; the importance of meteorological forecast is also discussed.

Les Développements du Système Radio-Mailles. Pierre Gaudillère. (*Internatl. Congr. Ausschuss Funkort., Berlin, May 19-24, 1958.*) *Navigation* (Paris), Oct., 1958, pp. 337–347. In French. Survey of the development of navigation, traffic-control, and anticollision systems.

Les Documents Cartographiques de Bord en Navigation Aérienne. P. Hugon. (*Internatl. Congr. Ausschuss Funkort., Berlin, May 19–24, 1958.*) *Navigation* (Paris), Oct., 1958, pp. 317–336. In French. Discussion covering various types of navigation charts and survey of modern requirements.

An Introduction to Space Navigation. Manuel Fernandez. *Astronautics*, Jan., 1959, pp. 23–25, 76. Analysis of the problem of navigation far removed from any body in the solar system. The information and equipment necessary to effect a celestial position fix are described, and various orientation techniques and problems are stated.

Aiding the Inertial Navigation System. Frederick Stevens. (*Inst. Navigation 14th Annual Meeting, Santa Barbara, June 19–21, 1958.*) *Navigation*, Autumn, 1958, pp. 166–174. Discussion of some of the limitations of inertial navigation, and analysis of methods of "aiding" it.

An Automatic Astro Compass. D. B. Nichinson. (*Inst. Navigation 14th Annual Meeting, Santa Barbara, June 19–21, 1958.*) *Navigation*, Autumn, 1958, pp. 182–189. General description of the compass and of some of the potentials of astro guidance. Navigation techniques made feasible by more automatic equipment are indicated.

Electronic Aids

Principles of Electronic Navigation Systems. P. C. Sandretto. *6th Internatl. Commun. Congr., Genoa, Oct. 10, 1958, Paper.* 29 pp. Discussion of the differences between single-path and multiple-path transmitter-receiver systems, and between such self-contained systems as star trackers, doppler systems, pressure measurement, and inertial measurement.

The Significance of Doppler in Jet Transports. J. S. Myers. (*Inst. Navigation 14th Annual Meeting, Santa Barbara, June 19–21, 1958.*) *Navigation*, Autumn, 1958, pp. 135–137. Discussion on the advantages and use of Doppler radar in air navigation.

Design Considerations for the APN-79 Airborne Doppler Navigation System. G. M. Miller. (*Inst. Navigation 14th Annual Meeting, Santa Barbara, June 19–21, 1958.*) *Navigation*, Autumn, 1958, pp. 147–156. Design and operation of the major components of the navigation system. The experimental model flight tests are briefly described.

El Radiofaro Omni-Range (VOR). E. A. Rodriguez. *Rev. Aero.*, Aug., 1958, pp. 603–610. In Spanish. Description of the operation of VOR systems.

Color Radar Displays to Aid the Controller's Task. F. C. White. *J. Air Traffic Control*, Oct., 1958, pp. 1–4, 18.

Selected Alpha-Numeric Characters for Closed-Circuit Television Displays. G. E. Rowland and D. Y. Cornog. *Courtney & Co. TR 21*, July 1, 1958. 21 pp. Development of a set of alpha-numeric characters for use in "Spanrad," a mixed display combining radar and television.

Traffic Control

The Air Traffic Control Paradox. P. C. Sandretto. *ITT FTL Paper*, May, 1958, 17 pp. 47 refs. Discussion of three different proposals to assemble and implement an air traffic control system.

A Partial Solution to the Air Traffic Control Problem Through Utilization of Aeronautical Video Plates. H. A. Thomas. *Navigation*, Summer, 1958, pp. 116–119.

Air Traffic Control and Autonavigators. Hans Giesecke. *Interavia*, Nov., 1958, pp. 1,208–1,210. Discussion of self-contained navigation systems and their potential applications.

RADC Evaluation of Decca Q-Band Radar Set. F. T. Benvenga. *USAF RADC TR 57-142 [AD 131263]*, Dec., 1957. 25 pp. Evaluation of the Decca radar as all-weather airport surface detection equipment.

Project Four Wheels. Appendix—**Principal Components of Facilities of Project "Four Wheels."** T. G. Burke. *USAF RADC TR 58-37 [AD 148652]*, Mar., 1958. 33 pp. Description of highly mobile, air transportable, communications and navigational facilities to support air operations under emergency or austere conditions.

Controlling the Civil Jets. T. K. Vickers. *J. Air Traffic Control*, July, 1958, pp. 1–9, 22. Discussion of simulation studies made by the CAA Technical Development Center.

A Novel Concept for Application to the Control of Airways Traffic. P. C. Sandretto and Mortimer Rogoff. (*Inst. Navigation 14th Annual Meeting, Santa Barbara, June 19–21, 1958.*) *Navigation*, Summer, 1958, pp. 102–107. Analysis of various traffic control systems. The VORTAC system, the maximum control limits, and the transference of information are examined.

Nuclear Energy

Reactor Shielding Analysis. C. C. Horton. *Nuclear Eng.*, Dec., 1958, pp. 515–520. Review of design problems in biological shielding of reactors, the general state of shielding analysis, and the way in which it differs from core design analysis.

Earth-to-Mars Flight. *Aircraft & Missiles Mfg.*, Dec., 1958, pp. 53–56. Discussion of the operation of the "magnetic pinch plasma engine." Mass ratio and electric propulsion are considered, and the performance characteristics of a Mars reconnaissance vehicle are briefly presented.

Development in the Field of Direct-Air-Cycle Aircraft Nuclear Propulsion Systems. H. Miller. *SAE Natl. Aero. Meeting, Los Angeles, Sept. 29-Oct. 4, 1958, Preprint 92B.* 14 pp. Presentation of preliminary results of tests to verify the design of a direct-air-cycle nuclear propulsion system.

Performance of Nuclear Electric Propulsion Systems. V. P. Kovacik and D. P. Ross. *IAS 27th Annual Meeting, New York, Jan. 26-29, 1959, Rep. 59-25.* 10 pp. 21 refs. Members, $0.50; nonmembers, $1.00. Presentation of the characteristics of major components in a nuclear propulsion system for use with preliminary design studies. The utility of electric propulsion for selected missions is also discussed.

Potentialities and Problems of Nuclear Rocket Propulsion. T. P. Cotter. (*IAS 27th Annual Meeting, New York, Jan. 26–29, 1959, Rep. 59-24.*) *Aero/Space Engrg.*, Feb., 1959, pp. 50–53. Evaluation of various types of rocket motors. The performance improvement of solid core motors and the evolution of a nuclear rocket motor are also discussed.

The Radiation Effects Testing of Aircraft Systems. M. M. Miller and A. M. Liebschutz. *SAE Natl. Aero. Meeting, Los Angeles, Sept. 29-Oct. 4, 1958, Preprint 92C.* 7 pp. Evaluation of aircraft systems' performance characteristics in a radiation environment. Environmental factors and requirements for conducting irradiations on dynamic systems are emphasized.

The Photoelectric Detection of Radiation. E. J. McCartney. *Sperry Eng. Rev.*, June, 1958, pp. 2–9. Survey of the field of electromagnetic radiation and discussion of its detection. The history of phototube development is given, and the characteristics of detectors are described. Noise factors and amplification problems are investigated.

The Behavior of Radiation and Turbine Lubricants. J. M. Clark, Jr., and G. C. Lawrason. *SAE Natl. Aero. Meeting, Los Angeles, Sept. 29-Oct. 4, 1958, Preprint 92D.* 17 pp.

Effects of Gamma Radiation on Organic Fluids and Lubricants. W. L. R. Rice. *Nucleonics*, Oct., 1958, pp. 112, 113.

Parachutes

Parachute Recovery of Guided Missiles. S. B. Jackson. *Shell Av. News*, Nov., 1958, pp. 18–20. Discussion of the recovery systems involving a constant compromise in fabric and cordage char-

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Photography

Development of a Satellite Acquisition Camera. J. T. Hedgepeth, Jr. *USAF FTC TN 58-43* [*AD 205633*], Nov., 1958. 23 pp. Description of a camera designed for positioning satellites of low visual magnitude. The principle of the instrument is to move the film at a rate proportional to the angular movement of the satellite. Since the image of a satellite is nearly stationary with respect to the film, the image area receives a relatively long exposure.

Design of a Lightweight Aerial Panoramic Camera. C. D. Cowles and Jules Cohen. *Photographic Sci. & Eng.*, Mar., 1958, pp. 161–165.

Radar Evaluation by Means of Aerial Photography. D. M. Montana. *USAF RADC TR 58-124* [*AD 202091*], Nov., 1958. 21 pp. Presentation of a photographic method for evaluating radar ability to determine the space position of a target. The fundamentals of optical verification of the space position of an aerial target, particularly the projection of the space position to a datum plane at the surface of the earth, are reviewed.

A New 70mm Automatically Controlled Aerial Camera. J. L. Bird and I. H. Franzel. *Photographic Sci. & Eng.*, Mar., 1958, pp. 166–171.

High-Altitude Small-Scale Aerial Photography. A. F. Di Pentima. *USAF RADC TN 58-165* [*AD 148777*], July, 1958. 27 pp. Description of the photographic apparatus used in a balloon at 100,000 ft. and evaluation of the photographs obtained.

Internal Camera Vibrations and Their Effect on Resolution. J. W. Herold. *Photographic Sci. & Eng.*, Jan., 1958, pp. 124–131. Test results indicating that a vibration-free camera is essential if stringent photographic requirements are to be met.

The Basic Geometric Principles of X-Ray Photogrammetry. Appendix—Some Practical Investigations Into the Accuracy of X-Ray Photographs. B. Hallert. *KTH Trans. 123*, 1958. 54 pp. Derivation of the fundamental projective relations between points in the object and the corresponding points in the image.

Physics

Electric Polarizability of the Neutron. G. Breit and M. L. Rustgi. *Yale U. Nuclear Phys. Div. Paper* (*AFOSR TN 58-1063*) [*AD 207223*], Dec. 3, 1958. 25 pp.

Paramagnetic Resonance and Optical Spectra of Single Crystal Oxides Containing Paramagnetic Impurities. W. Low. *Hebrew U. Dept. Phys. TN 3* (*AFOSR TN 58-882*) [*AD 203906*], July, 1958. 35 pp. 28 refs.

High Resolution Microradiography. B. L. Henke. *Pomona Coll. Dept. Phys. TR 2* (*AFOSR TN 58-803*) [*AD 202236*], Sept., 1958. 65 pp.

Thermoluminescence and F Centers. Guido Bonfiglioli, Piero Brovetto, and Cesare Cortese. *Inst. Elettrotec. Naz. "Galileo Ferraris" Final Rep. (Res. b)* (*AFOSR TR 58-134*) [*AD 204428*], Sept., 1958. 31 pp.

Dispersion Relations and Schwartz's Distributions. J. G. Taylor. *Ann. Phys.*, Dec., 1958, pp. 391–398. 10 refs. AFOSR-supported research.

Investigation of Magneto-Ionic Fading in Oblique Incidence Medium-Wave Transmissions. M. S. Rao and B. R. Rao. *J. Atmos. & Terrestrial Phys.*, July, 1958, pp. 293–305.

A Study of Air Flow in a Large-Ion Chamber. G. A. Faucher. *J. Atmos. & Terrestrial Phys.*, July, 1958, pp. 288–292. Development of a technique to investigate the flow in a large-ion chamber with titanium tetrachloride smoke. The experimental apparatus and results are described.

Annihilation of Positrons in Organic Compounds. Ch. R. Hatcher, W. E. Millett, and Louis Brown. (*Phys. Rev.*, July 1, 1958, pp. 12–15.) *Texas U. TR* (*AFOSR TR 58-138*) [*AD 152165*], Nov., 1958. 4 pp. 19 refs. Reprint.

Electron Spin Resonance Studies of Irradiated Teflon: Effects of Various Gases. H. N. Rexroad and Walter Gordy. *Duke U. Dept. Phys. Microwave Lab. Rep. 23* (*AFOSR TN 58-870*) [*AD 203715*], Aug. 1–Nov. 1, 1958. 10 pp. 10 refs.

Electron Spin Resonance in an Irradiated Single Crystal of Dimethylglyoxime. Ichiro Miyagawa and Walter Gordy. *Duke U. Dept. Phys. Microwave Lab. Rep. 23* (*AFOSR TN 58-1034*) [*AD 206484*], Aug. 1–Nov. 1, 1958. 14 pp

Theory of the Cavity Microwave Spectrometer and Molecular Frequency Standard. Yardley Beers. *NYU Coll. Eng. Res. Div. Rep.* (*AFOSR TN 58-871*) [*AD 203714*], Sept. 12, 1958. 24 pp. 13 refs.

Microwave Method for Measuring the Probability of Elastic Collision of Electrons in a Gas. J. L. Hirshfield and S. C. Brown. *J. Appl. Phys.*, Dec., 1958, pp. 1,749-1,752. 14 refs. USAF-Army-Navy-supported research.

Recent Advances in Determination of Radiative Properties of Gases at High Temperatures. J. G. Logan, Jr. *Jet Propulsion*, Dec., 1958, pp. 795–798. 52 refs.

New Metastable State of Mercury. William Lichten. (*Phys. Rev.*, Feb. 15, 1958, pp. 1,191, 1,192.) *Columbia U. Paper* (*AFOSR TN 58-696*) [*AD 162230*], Oct. 16, 1957. 2 pp. Reprint.

Calculation of the $O^{16}(d,p)O^{17}$ Angular Distribution. J. L. Richter and E. V. Ivash. (*Phys. Rev.*, July 1, 1958, pp. 245–249.) *Texas U. TN* (*AFOSR TN 58-192*) [*AD 152225*], Nov., 1958. 5 pp. 15 refs. Reprint.

On Das' Theory of Nuclear Magnetic Resonance in Solids. J. W. McGrath and A. A. Silvidi. (*J. Chem. Phys.*, July, 1958, pp. 103–105.) *USAF OSR TN 58 245* [*AD 154147*], July, 1958. 3 pp. Reprint.

Parallactic Measurements on Aurorae Over Churchill, Canada. D. J. McEwen and R. Montalbetti. *Can. J. Phys.*, Dec., 1958, pp. 1,593–1,600.

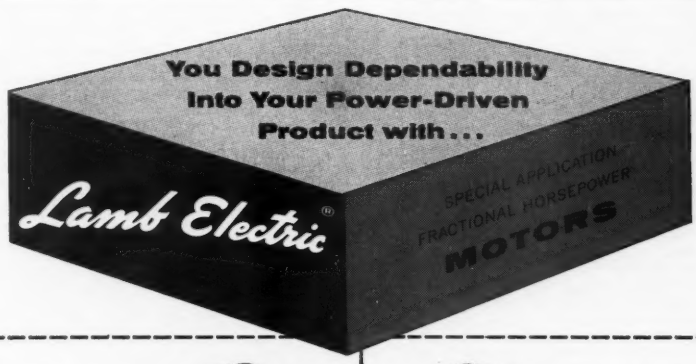
Horizontal Motions in Radar Echoes from Aurora. G. F. Lyon and A. Kavadas. *Can. J. Phys.*, Dec., 1958, pp. 1,661–1,671. 18 refs.

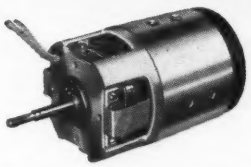
Investigation of the Drifts of the Effective Point of Radio Reflection Along a Meteor Train. M. S. Rao and R. L. Armstrong. *Can. J. Phys.*, Dec., 1958, pp. 1,601–1,623. 15 refs.

Thermometric Study of the Frozen Products from the Nitrogen Microwave Discharge. B. J. Fontana. *J. Appl. Phys.*, Dec., 1958, pp. 1,668–1,673. 15 refs. Study of the phenomena accompanying the stabilization and the recombination of free nitrogen atoms in a solid molecular nitrogen matrix at liquid helium temperatures.

Time-Correlation Functions in the Statistical Mechanics of Transport Processes. Hazime Mori. (*Phys. Rev.*, Aug. 1, 1958, pp. 694–706.) *Brown U. Paper*, Aug. 1, 1958. 13 pp. 26 refs. Reprint.

Transport Equation in Quantum Gases. Hazime Mori and John Ross. (*Phys. Rev.*, Mar. 15, 1958, pp. 1,877–1,882.) *Brown U. Paper*, Mar. 15, 1958. 6 pp. 22 refs. Reprint.





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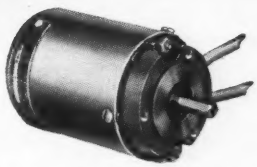
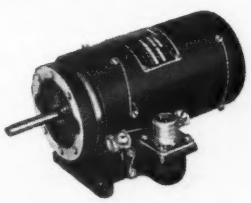


Six-pole 400 cycle AC motor for electronic cooling in missile control equipment. Frame 1 11/16 x 1¼



Totally enclosed fan-cooled 27 volt DC motor for pump drive. Frame 2 x 1½

24 Volt DC fuel valve actuator incorporates gear train torque-limiting clutch and limit switches. Frame 1⅜ x 9/16

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Generation of High-Velocity Projectiles. M. A. Cook and R. T. Keyes. *J. Appl. Phys.*, Dec., 1958, pp. 1,651–1,657. 12 refs. AFOSR-supported application of a technique for controlling the shape of detonation wave fronts in high explosives by inert wave control inserts to the generation of discrete ultra-high velocity pellets. Tests to determine the most suitable pellet shape, as well as the optimum charge configuration, are described.

A Poynting Theorem for Moving Bodies and the Relativistic Mechanics of Extended Objects. N. H. Meyers. *Franklin Inst. J.*, Dec., 1958, pp. 439–464.

Investigation of Electromagnetic Launcher for High-Speed Projectiles. J. L. Radnik and A. Bak. *Ill. Inst. Tech. ARF Proj. E064 Final Rep. (AFOSR TR 58-84)* [*AD 158393*], May, 1958. 67 pp. Study of the design and performance characteristics of a parallel rail electromagnetic accelerator to determine the feasibility of the linear motor accelerator as a research tool capable of accelerating small particles to velocities of 25,000 ft./sec. and above.

Solar Furnace Support Studies. *USAF MDC TR 58-7* [*AD 135014*], 1958. 210 pp. 18 refs. Presentation of ten papers on the use of solar energy and the design of a proposed solar furnace.

The Effect of Certain Solar Radiations on the Lower Ionosphere. R. E. Houston, Jr. *J. Atmos. & Terrestrial Phys.*, July, 1958, pp. 225–235. 30 refs. USAF-sponsored computation of an electron density distribution in the *D* and *E* regions of the ionosphere. Various Lyman and X-radiations are considered. A comparison of the resulting electron density distribution model with experimental values is made.

Materials for Infrared Windows, Domes, Lenses. H. F. Hoesterey. *Electronics*, Jan. 16, 1959, pp. 56, 57.

Calculation of the Thermal Expansion of Solids from the Third-Order Elastic Constants. F. W. Sheard. *Philos. Mag., 8th Ser.*, Dec., 1958, pp. 1,381–1,390. 21 refs.

Dynamic Compressibility of Metals Under Pressures from 400,000 to 4,000,000 Atmospheres. L. V. Al'tshuler, K. K. Krupnikov, and M. I. Brazhnik. (*Zhurnal Teoret. i Exper. Fis.*, Apr., 1958, pp. 886–893.) *Sov. Phys.-JETP*, Oct., 1958, pp. 614–619. Translation. Presentation of a method based on the measurement of the velocities of propagation of strong shock waves in order to determine the pressure and densities of shock compressions. The dynamic compressibility of several metals measured by this method is presented.

On the Lateral Distribution of Particles in Extensive Air Showers. G. B. Khristiansen. (*Zhurnal Teoret. i Exper. Fis.*, Apr., 1958, pp. 956–961.) *Sov. Phys.-JETP*, Oct., 1958, pp. 661–664. 17 refs. Translation. Analysis of the relative role of various factors affecting the lateral divergence of charged particles in extensive air showers.

Atomic Masses of Kr^{84}, Kr^{86}, Xe^{129}, Xe^{132}, Hg^{200}, Hg^{201}, and Hg^{204}. J. T. Kerr and H. E. Duckworth. (*Can. J. Phys.*, July, 1958.) *USAF OSR TN 58-505*, Aug. 1, 1958. 4 pp. 11 refs. Reprint.

Cosmic Boomerang. G. Chebotarev. *Spaceflight*, Oct., 1958, pp. 315, 316. Translation. Discussion of the trajectory to be followed by a missile on a round-trip to the moon.

Low-Frequency Reflection in the Ionosphere. II. Hermann Poeverlein. *J. Atmos & Terrestrial Phys.*, July, 1958, pp. 236–247. 23 refs. Development of a theory for ionospheric reflection of wavelengths comparable to, or greater than, the layer thickness. Various ranges of data are specified and their reflection characteristic investigated. Some consequences of the theory are also discussed.

Is Newton's Law of Gravitation Really Universal? Fritz Zwicky. *Astronautics*, Jan., 1959, pp. 18, 19, 74, 76. Formulation of Newton's law of gravitation and examination of its range of validity through the interactions between clusters of galaxies.

Strong Gravitational Waves in Free Space. A. S. Kompaneets. (*Zhurnal Teoret. i Exper. Fis.*, Apr., 1958, pp. 953–955.) *Sov. Phys.-JETP*, Oct., 1958, pp. 659, 660. Translation. Analysis generalizing the results of Einstein and Rosen to the case of two interacting gravitational waves.

Charting Space. F. H. Green. *New Frontiers*, Fall, 1958, pp. 3–7. Discussion of early and recent studies of atmospheric properties; results are recorded in a series of charts. High altitude charts and their significant features are described.

The Clock Paradox. W. F. Campbell. (*CAI 1st Meeting Astronautics Sect., Ottawa, Oct. 9, 1958.*) *Can. Aero. J.*, Nov., 1958, pp. 316–319. 19 refs. Brief explanation of the clock paradox that results from the special theory of relativity, and presentation of possible solutions.

Cyclotron Resonance in Flames. Jürgen Schneider and F. W. Hofmann. *Duke U. Dept. Phys. Microwave Lab. Rep. 23 (AFOSR TN 58-1035)* [*AD 206481*], Aug. 1–Nov. 1, 1958. 3 pp.

Relative Detection Efficiency of LiBr and $(LiBr)_3$. P. Kusch. (*J. Chem. Phys.*, June, 1958, pp. 1,075–1,078). *Columbia U. Paper (AFOSR TN 58-102)* [*AD 152010*], Feb. 4, 1958. 4 pp. Reprint.

Power Plants

Atmosphere Breathing Engines in Astronautics. S. W. Greenwood and D. S. Carton. (*Brit. Interplan. Soc. Midlands Branch Meeting, Nov. 9, 1957.*) *Coll. of Aeronautics, Cranfield, Note No. 88*, Oct., 1958. 22 pp. 10 refs. Analysis of the possibilities of using ram-jets (a) as a power source for one of the stages of a satellite launching vehicle and (b) in the atmosphere of other planets.

Raumfahrzeugantriebe und Satellitenmessungen. (*9th Internatl. Astron. Congr., Amsterdam, Aug. 25–30, 1958.*) *Luftfahrttechnik*, Oct. 15, 1958, pp. 288–291. 65 refs. In German. Survey of approximately 60 papers covering propellants, combustion, propulsion systems for space vehicles, and satellite data.

Propellents for Space Flight. T. F. Dixon. *Air BP*, No. 9, pp. 8–11. Analysis of the implications of astronautical experiments made during the International Geophysical Year.

Combustion Chamber Pressure Loss. S. L. Bragg and S. P. Q. Byworth. *Jet Propulsion*, Dec., 1958, p. 829. Calculation of the ratio between the total pressure at the throat and the static pressure at the injector plate.

Prophecy for Propulsion—One Man's Guess. T. F. Dixon. (*IAS 27th Annual Meeting, New York, Jan. 26–29, 1959.*) *Aero/Space Engrg.*, Feb., 1959, pp. 35–39. 22 refs. Discussion of the possible development in chemical and nuclear rockets, evaluated in terms of the propulsion requirements of certain space missions.

Jet & Turbine

A Theoretical Consideration on the Vibration of Turbine Blade System. Tsutomu Fujino. *JSME Bul.*, No. 2, 1958, pp. 119–123. Analysis of a turbine blade system having a shroud at the periphery. This constitutes a vibration system having normal vibrations of a fixed-free type, and also a vibration system of fixed-supported type.

Nekotorye Zadachi Termouprugosti v Sviazi s Teplovymi Napriazheniiami v Turbinnykh Rotorakh. H. D. Kovalenko. *AN SSSR Otd. Tekh. Nauk Izv.*, Oct., 1958, pp. 68–76. In Russian. Study of various problems of thermoelasticity as related to thermal stresses in turbine rotors. Includes description of methods used in the investigation and presentation of experimental results.

Structural Design and Preliminary Evaluation of a Light Weight, Brazed, Air-Cooled Turbine Rotor Assembly. A. J. Meyer, Jr., and W. C. Morgan. *U.S., NASA Memo. 10-5-58E*, Dec., 1958. 25 pp. Stress analysis of a turbine rotor assembly for short-life expendable missile application resulting in a 50 per cent weight reduction over a conventional turbine. Two rotor blade configurations with simulated full wheel attachment were tested. Results are given and suggestions for overcoming the vibration problem are made.

Survey of the World's Aircraft Engines. *Interavia*, Dec., 1958, pp. 1,279–1,284. Tabular presentation of performance characteristics of the piston, turbine, and rocket engines now in production or operation.

The Development of the Avon RA.29 Engine for Civil Jet Transport. E. Eltis. *Interavia*, Dec. 1958, pp. 1,269–1,272.

SNECMA'S Supersonic Turbojet. *Interavia*, Dec. 1958, pp. 1,291, 1,292.

Bristol-Staustrahltriebwerke und die Zukunft. R. R. Jamison. *Luftfahrttechnik*, Oct. 15, 1958, pp. 286–288. In German. Discussion covering the possibility of combining ram-jet and turbojet propulsion for application to supersonic transport aircraft, and evaluation of the superiority of such a system over conventional jet and turbine power plants.

Development of the CJ-805-21 Turbofan Engine. A. P. Fioretti. *Interavia*, Dec., 1958, pp. 1,266–1,268.

The British Engine Scene. *Air Pictorial*, July, 1958, pp. 226–234, 258. Survey of various power plant types in terms of their application.

The T55 Gas Turbine Family. K. E. Luther, Jr. *AHS Newsletter*, Nov., 1958, pp. 2–8. Design and performance characteristics of the Lycoming engine for turboprop or helicopter application.

Titan Turbine Makes Debut. *Solar Quart.*, Spring, 1958, pp. 7–9. Brief description of a 55-hp. motor having a centrifugal compressor, developed to power one-man helicopters and flying platforms.

DB's and Design; The Engine Manufacturer's Point of View. Appendix—Empirical Method for Noise Estimation. H. J. Nozick. *SAE Natl. Aero. Meeting, Los Angeles, Sept. 29-Oct. 4, 1958, Preprint 85B.* 9 pp. 13 refs. Discussion of the engine characteristics that contribute significantly to the commercial requirements of performance and reliability. Specific fuel consumption and turbine inlet temperature are quantitative measures of these criteria. It is shown that by satisfying the performance and reliability requirements, the problem of noise generation is alleviated.

DC-8. L. R. Jordan and C. M. Auble. (*SAE Natl. Aero. Meeting, Los Angeles, Sept. 29-Oct. 4, 1958, Preprint 85A.*) *SAE J.*, Dec., 1958, pp. 49–52. Description of the development test program and discussion of the selection of suppressor and thurst brake designs.

Practical Experience on Thrust Reversers. K. I. C. Vincent. *SAE Natl. Aero. Meeting, Los Angeles, Sept. 29-Oct. 4, 1958, Preprint 85C.* 15 pp. Description of the test programs and brief review of various types of thrust reversers.

Ram-Jet & Pulse-Jet

Ramjets for Aeroplanes—The Optimum Power Unit for Supersonic Flight. *Bristol Quart.*, Summer, 1958, pp. 212–216.

Rocket

Cálculos de un Motor Cohete Típico. R. V. Dyrgalla. *Asoc. Argent. Interplan. Rev.*, Jan.-June, 1958, pp 1–6. In Spanish. Survey of parameters for the calculation of a typical rocket engine.

The Spectre Rocket Engine. *de Havilland Gazette*, Dec., 1958, pp. 212–216. Abridged. Includes design considerations, bench and flight testing, and future developments of the Spectre engine.

On the Importance of the Sensitive Time Lag in Longitudinal High-Frequency Rocket Combustion Instability. Luigi Crocco, Jerry Grey, and D. T. Harrje. *Jet Propulsion*, Dec., 1958, pp. 841–843. Experimental investigation showing that there is an upper limit to the chamber length at which each mode of longitudinal high-frequency pressure oscillations will occur, and that this limit was accurately predicted for the fundamental mode by Crocco's sensitive time lag theory over a wide range of mixture ratios.

Production

Thiokol Stresses R&D on Rocket Motors. Craig Lewis. *Av. Week*, Jan. 5, 1959, pp. 42, 43, 45–54 (ff.). Discussion of Thiokol's expansion for the production of solid-propellant rocket motors. The handling of the engine casing and the mixing, curing, and quality-control testing of the propellant are all described.

Rotodyne Rotor-Blade. II—Forming Stainless-Steel Ribs and Skin: Aerofoil Assembly. *Aircraft Prod.*, Dec., 1958, pp. 483–488.

Tooling Approach to Arrow Aircraft. E. B. Bragg. (*CAI Annual Gen. Meeting, Toronto, May 27, 1958.*) *Can. Aero. J.*, Dec., 1958, pp. 362–370. Illustration of the planning and tooling of various parts of the Arrow. The magnitude of the tasks involved is discussed.

Metalworking

Sandwich Panel Construction. R. A. Cole. *Aircraft & Missiles Mfg.*, Dec., 1958, pp. 48–52. Analysis of design, production, and inspection considerations.

Some Applications of Stress Analysis Techniques in Improving Casting Designs. L. H. Ravitch. *GM Eng. J.*, Oct.-Dec., 1958, pp. 22–27.

How to Cast Curved Passageways. G. Sandenburgh. *Aircraft & Missiles Mfg.*, Dec., 1958, pp. 29–32. Discussion of the development and typical applications of glass-like tubes bent or joined to form the desired configuration. The core material is removed after the casting operation by a hydrofluoric acid bath.

Experiments in the Cold Extrusion of Rods of Non-Circular Section. W. Johnson. *J. Mech. & Phys. Solids*, Nov., 1958, pp. 37–44. Investigation covering the effects of section shape and punch speed on the necessary extrusion load, as well as the nature of the flow of metal within the extruded rod.

Automatic Spinning for Conical Shapes. *Prod. Eng.*, Jan. 5, 1959, pp. 46, 47. Description of a process using powered rollers under tracer control to obtain conical shapes with a wall thickness proportional to sine of the cone angle.

Powered Spinning—Important Development in Metal Forming. *Prod. Eng.*, Jan. 5, 1959, pp. 42–45.

Coextruded Parts Can Simplify Design. N. R. Gardner. *Materials in Des. Eng.*, Dec., 1958, pp. 91–93. Discussion of the coextrusion that is produced by forcing two or more materials through a die at elevated temperatures. Advantages and disadvantages are listed, and consideration is given to materials, shapes, sizes, tolerances, and applications.

Processing Wrought Steel to High Strength. L. H. McCreery. *SAE Natl. Aero. Meeting, Los Angeles, Sept. 29-Oct. 4, 1958, Preprint 82B.* 19 pp. Discussion of processing 4340 steel, including hot working, machining, heat treating, and finishing.

Etching and Routing; Comparative Speeds and Economic Applicability of the Processes. *Aircraft Prod.*, Dec., 1958, pp. 459–463.

Ultrasonic Welding; Types of Equipment; Progress in Development. J. B. Jones and W. C. Potthoff. *Aircraft Prod.*, Dec., 1958, pp. 492–495.

Production Engineering

Design Change Impacts on Airframe Parts Inventories. J. W. Petersen and W. A. Steger. *Nav. Res. Logistics Quart.*, Sept., 1958, pp. 241–255. Study based on figures from the F-94 production and operation, and partly from those of the F-100 and B-52. Indications are that over the life of a weapon the cost of airframe-spares design changes, including obsolescence and modification of delivered spaces, in-plant obsolescence, and limited use may eventually be as much as 10 per cent of the value of delivered spares.

Sources of Helicopter Development and Manufacturing Costs. J. B. Nichols. *IAS 27th Annual Meeting, New York, Jan. 26–29, 1959, Rep. 59-11.* 21 pp. Members, $0.50; nonmembers, $1.00. Presentation of a cost study determining the effect of design, specification requirements, production quantity, and production rate on development, tooling, testing, engineering change proposals, and operating costs.

Quality Control at the Crossroads. E. C. Burkhart. *Ind. Quality Control*, Aug., 1958, pp. 12–20. 15 refs. Discussion of the need for improvements in quality control and the changing objectives of military quality control programs.

Non-Destructive Testing. IV—Development of Radiographic Methods of Inspection: Examination of Aircraft Structures. *Aircraft Prod.*, Dec., 1958, pp. 464–482.

Some Theoretical and Practical Aspects of Tolerances for Mating Parts. I. W. Burr. *Ind. Quality Control*, Sept., 1958, pp. 18–22.

An Acceptance Sampling Plan. B. Ostle and J. M. Wiesen. *Ind. Quality Control*, Sept., 1958, pp. 8, 9. Study based on the distribution of the range when sampling from a triangular population.

Multi-Level Continuous Sampling Procedures and Tables for Inspection by Attributes. W. G. Ireson and R. E. Biedenbender. *Ind. Quality Control*, Oct., 1958, pp. 10–14.

Effect of Temperature Conditions and Coefficients of Thermal Expansion on Accurate Gaging. N. F. Kans. *Ind. Quality Control*, Sept., 1958, pp. 22–27.

A Method of Comparing the Roundness of Bearing Balls. W. R. Hinton. *Gt. Brit., RAE TN El. 152*, June, 1958. 19 pp.

Propellers

Flight Measurements of the Vibratory Stresses on a Propeller Designed for an Advance Ratio of 4.0 and a Mach Number of 0.82. T. C. O'Bryan. *U.S., NACA TN 4410*, Sept., 1958. 14 pp.

Reliability

Monitoring Reliability. *Aircraft & Missiles Mfg.*, Dec., 1958, pp. 26–28. Outline of a proposed reliability monitoring program for use with guided-missile weapons systems projects.

The Exponential Distribution and Its Role in Life Testing. Benjamin Epstein. *Ind. Quality Control*, Dec., 1958, pp. 4–9. 17 refs. Study considering the use of an exponential model for life in reliability testing.

Research, Research Facilities

Simulation Techniques in Aeronautics. J. J. Foody and R. J. A. Paul. *RAeS. J.*, Dec., 1958, pp. 878–892. 14 refs. Discussion of simulation techniques for aircraft control systems.

Aircraft Control Load Simulator. *Shorts Quart. Rev.*, Dec., 1958, pp. 21–23. Description of the operation and application of the mechanical load simulator.

Aeroballistics Range Measurements of the Performance and Stability of Supersonic Aircraft. H. R. Warren, R. J. Templin, and B. Cheers. (*IAS 26th Annual Meeting, New York, Jan. 27–30, 1958, Preprint 748.*) *Can. Aero. J.*, Dec., 1958, pp. 351–361. 17 refs.

Rigid Dummy Loads for Shock and Vibration Tests. B. J. Forsher. *Environmental Quart.*, 4th Quart., 1958, pp. 10, 22, 27.

Gaseous Oxygen Test Laboratory; Functional Environment for Missile Equipment Studies. A. L. Spangenberg. *Missile Des. & Devel.*, Dec., 1958, pp. 20–24.

The Rolls-Royce High Altitude Test Facility; A Description of the Large New Plant at Derby. *Aircraft Eng.*, Dec., 1958, pp. 367–369.

Effectiveness of Troops Exposed to Thermal Radiation from Nuclear Weapons. W. A. Langevin, R. Greenstone, and C. O. Elder. *Oper. Res.*, Sept.-Oct., 1958, pp. 710–722.

Two Uses of the Diffused-Target Concept in Aerial Target Analysis. W. A. Thompson, Jr. *Oper. Res.*, Sept.-Oct., 1958, pp. 671–675. Application of a theory, called the diffused target concept, to the problem of studying the adequacy of a fuze under operational conditions.

Some Principles for a Data-Processing System in Logistics. M. A. Geisler. *Nav. Res. Logistics Quart.*, June, 1958, pp. 95–105. 11 refs.

Flight Testing

A Flight Technique for the Measurement of Thrust Boundaries and of Drag Due to Lift. H. D. Rylands. *Gt. Brit., ARC CP 405* (Nov., 1956) 1958. 15 pp. BIS, New York, $0.45.

Laboratory and Flight Tests of Chemical Tracking Aids Performed for Project 6875 During Period August 1954 Through September 1956. D. L. Ekstedt. *USAF MDC TR 58-2 [AD 123736)*, July, 1958. 100 pp. Investigation on liquid smoke agents and experimental smoke generators for acquisition and tracking of aircraft and missiles.

Performance of the Balloon Launched Hypersonic Test Vehicle, HTV I, in Vertical Descent. H. O. F. Scharn. *USAF MDC TN 58-9 [AD 154101]*, June, 1958. 14 pp. Investigation to establish the scope of Reynolds Numbers and Mach Numbers obtainable with the HTV I balloon rocket.

Measuring In-Flight Thrust of a Turbojet-Powered Aircraft. W. J. Coleman and D. F. DeSanto. (*NATO AGARD Flight Test Panel, Paris, Apr. 21–25, 1958.*) *NATO AGARD Rep. 197*, Apr., 1958. 38 pp. 40 refs. Discussion of the present state of the art in instrumentation and techniques for determining in-flight thrust, with the shortcomings of current systems and methods pointed out.

All-Weather Testing in the United States Air Force. L. G. Gamble. (*NATO AGARD Flight Test Panel, Paris, Apr. 21–25, 1958.*) *NATO AGARD Rep. 200*, Apr., 1958. 8 pp. Description of two phases of all-weather testing—the extreme temperature ground testing and the weather flight phase.

Rocket Sleds, Tracks

Importance of Track Testing in Guided Missile R & D. H. T. Schwinge. *Holloman Mo. News Bul.*, June, 1958, pp. 2, 4, 9, 10. Description of track testing and of its advantages over other missile testing methods.

Precision Measurement of Supersonic Rocket Sled Velocity. II. F. J. Beutler and L. L. Rauch. *Jet Propulsion*, Dec., 1958, pp. 809–816. Analysis indicating that the addition of a sled-borne accelerometer suffices to insure attainment of the quoted velocity accuracy if accelerometer and track coil data are combined in an optimum manner.

Wind Tunnels

The Development of Slotted Working-Section Liners for Transonic Operation of the R.A.E. Bedford 3-ft Wind Tunnel. Appendix—Transonic Characteristics of Two Static Heads and the Estimation of the True Free-Stream Mach Number. E. P. Sutton. *Gt. Brit., ARC R & M 3085* (Mar., 1955) 1958. 26 pp. BIS, New York, $1.80.

A System for Handling Wind-Tunnel Data. J. F. M. Scholes. *Gt. Brit., RAE TN Aero. 2573*, May, 1958. 20 pp.

Convair's New Trisonic Wind Tunnel. W. T. MacCarthy. *SAE Natl. Aero. Meeting, Los Angeles, Sept. 29-Oct. 4, 1958, Preprint 84B.* 13 pp. Description of a blowdown tunnel using two different 4 × 4 ft. test sections, one ranging from Mach Numbers 0.5 to 1.8 and the other from 1.2 to 5.0.

"Hot-Shot" Wind Tunnel Uses Arc Heating. Ronald Smelt and T. E. Turner. (*SAE Natl. Aero. Meeting, Los Angeles, Sept. 29-Oct. 4, 1958, Preprint 84A.*) *SAE J.*, Dec., 1958, pp. 54, 55.

La Nuova Galleria Aerodinamica dell'Istituto di Aeronautica dell'Università di Napoli. Salvatore Montuoro. *L'Aerotecnica*, Aug., 1958, pp. 221–226. In Italian. Description of the new wind tunnel of the Institute for Aeronautics of the University of Naples.

Wind Tunnels and Their Extension Into the Future. J. T. Kenney, P. V. H. Serrell, and Y. N. Yu. *SAE Natl. Aero. Meeting, Los Angeles, Sept. 29-Oct. 4, 1958, Preprint 84C.* 8 pp. Discussion of requirements for current wind tunnels and such future types as the ultra hypersonic and the plasma tunnels.

A Survey of New Developments in Pressure Measuring Techniques in the N.A.C.A. John Dimeff. (*NATO AGARD Wind-Tunnel & Model-Testing Panel, London, Mar. 24-28, 1958.*) *NATO AGARD Rep. 166*, Mar., 1958. 25 pp. Description of several transducers designed to meet the particular needs of research within the NACA. An experimental transducer is presented in which the deforming member is a thin layer of dielectric which is compressed under the action of the unknown pressure; initial results obtained with this transducer are given.

Dépouillement Automatique des Mesures de Pression en Soufflerie. R. Moreau. (*NATO AGARD Wind-Tunnel & Model-Testing Panel, London, Mar. 24-28, 1958.*) *NATO AGARD Rep. 167*, Mar., 1958. 16 pp. In French. Description of an investigation resulting in the automatic performance of certain measurement operations in the case of wind-tunnel pressure measurements, in particular, the elimination, as much as possible, of the human factor in the chain of operations between the multimanometer and

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the punched card. The basic principle of the solution is stated, and the automatic handling equipment, its performance, and use are described.

Some Factors Involved in the Supersonic Wind Tunnel Testing of Models. P. A. Champion. *RAeS J.*, Dec., 1958, pp. 893–897. Discussion of problems in interference, starting loads, errors in geometrical scaling, and condensation.

Real Gas Effects on Shock-Tube Performance at High Shock Strengths. J. L. Stollery. *Gt. Brit., ARC CP 403* (Nov., 1957) 1958. 23 pp. 13 refs. BIS, New York, $0.63.

Investigation Into the Use of Freon 12 as a Working Medium in a High-Speed Wind-Tunnel. O. M. Pozniak. *Coll. of Aeronautics, Cranfield, Note No. 72*, Nov., 1957. 141 pp. 43 refs. Discussion covering the design of the Freon 12 wind-tunnel and investigation of its use for aerodynamic measurements. A correlation is made of these measurements with similar ones made in air. The factors affecting the choice of heavy gases are discussed.

Rotating Wing Aircraft, Helicopters

H-43B Tailored to USAF Rescue Concept. E. J. Bulban. *Av. Week*, Dec. 22, 1958, pp. 71–75. Design characteristics of the Lycoming T-53 powered rescue helicopter.

Increase in Helicopter Payload Through Running Takeoff. G. N. Adams and H. G. Sevier. *Can. Aero. J.*, Sept., 1958, pp. 224–226. Description of the take-off technique, and demonstration of the increase in payload-range capability for a particular helicopter.

A Method of Calculating the Effect of One Helicopter Rotor Upon Another. I. C. Cheeseman. *Gt. Brit., ARC CP 406*, Apr., 1958. 18 pp. BIS, New York, $0.54.

Differential Equations of Motion for Combined Flapwise Bending, Chordwise Bending, and Torsion of Twisted Nonuniform Rotor Blades. Appendix A—Derivation of Longitudinal Strains. Appendix B—Derivation of Accelerations and Inertia Loadings. J. C. Houbolt. *U.S., NACA Rep. 1346*, 1958. 17 pp. 19 refs. Supt. of Doc., Wash., $0.25.

Helicopter Control Stick Steering. Lawrence Kaufman. *Sperry Eng. Rev.*, Oct., 1958, pp. 41–48. Discussion of some of the leading design problems of helicopter control stick steering, and presentation of practical solutions to the problem involved in the integration of automatic and primary control systems.

Safety

Special Issue: A Report on Aviation Safety. *Aircraft* (Canada), Dec., 1958, pp. 35–59, 76–85. *Partial Contents:* New Flight Safety Standards Through Automation in the Cockpit. Safety in Flight Through Fluorescent Paints. Safety in Flight Through Proximity Warning. Insuring Flight Safety by Fuel Decontamination. Safety in Flight Through Speed Control. Flight Safety at Ground Level with Anti-Skid Devices. Escape from Danger. The Versatile Parachute. Aids for Survival.

Preliminary Field Evaluation of a Naval Aircraft Running Light Configuration. D. V. Cornog, G. E. Rowland, and Douglas Courtney. *Courtney & Co. Final Rep. 20*, Apr. 30, 1958. 93 pp. Presentation of ground and flight tests of a proposed aircraft running light configuration to determine whether it provides the necessary information to an observing pilot.

Space Travel

The Challenge of the Space Age. R. B. Filbert, Jr. *Battelle Tech. Rev.*, Nov., 1958, pp. 3–7. Discussion of the problems of propulsion, guidance, and control of space vehicles. Environmental problems, requirements for better materials and high reliability, and contingent problem areas are also discussed.

SFI—A Prime Factor in Space Technology. Irvin Kane. *ARMA Eng.*, Oct.-Nov., 1958, pp. 25–27. Discussion on the importance of space flight instrumentation (SFI) for space exploration. A compilation of SFI requirements is made, and the need for original scientific approaches to problem areas is advocated.

Note on Interplanetary Navigation. R. M. L. Baker, Jr. *Jet Propulsion*, Dec., 1958, pp. 834, 835. Discussion of some self-contained navigation systems making maximum use of precomputed data.

Interplanetary Probes: Three Problems. Krafft Ehricke. *Astronautics*, Jan., 1959, pp. 20–22, 42, 44, 46. Discussion covering the limitations in launching vehicles to Mars and Venus, the errors affecting the flight path, and the midcourse guidance requirements.

Soviet Technical Progress. R. C. Wakeford. *Space J.*, Fall, 1958, pp. 4–11. Description of the Soviet satellite Sputnik II and discussion of other animal experiments in space. Includes some details of the instrumentation of Sputnik III.

Rocket Astronomy—Window Into Space. Herbert Friedman. *Astronautics*, Jan., 1959, pp. 26, 27, 69, 70. Discussion covering the use of rocket and satellite vehicles equipped with photon-counter telescopes for astronomical observations.

Man-Machine Integration in Space Vehicles. G. W. Hoover. (*IAS 27th Annual Meeting, New York, Jan. 26–29, 1959, Rep. 59-51.*) *Aero/Space Engrg.*, Feb., 1959, pp. 54–58. Discussion covering the man's role in the overall space man-machine complex, as well as the importance of a space vehicle design which will meet man's requirements.

Aerodynamics in Space Travel. F. W. Ross. *Solar Quart.*, Spring, 1958, pp. 3–6. Discussion of aerodynamic and other problems involved in a trip to Mars and the re-entry into the atmosphere.

Life on Other Stars. II. Ernst Stuhlinger. *Space J.*, Summer, 1958, pp. 21–30. Discussion of the biological state of other planets and of the possibilities of animal life on these planets.

Can We Live in Space—Environmental Problems of Space Flight Are Studied at Litton. *CEC Recordings*, Fall, 1958, pp. 14–16.

Hydroponics. Stephen Keeler. *Spaceflight*, Oct., 1958, pp. 324, 325. Discussion of methods of chemical farming and their role in producing oxygen for future flights.

Space-Stations—To Be or Not to Be. H. E. Ross. *Spaceflight*, Oct., 1958, pp. 311–314, 316. Discussion covering the functions of a space station, as well as size, weight, and economic considerations, along with communication problems.

Tracking Orbits of Man-Made Moons. C. A. Schroeder, C. H. Looney, Jr., and H. E. Carpenter, Jr. *Electronics*, Jan. 2, 1959, pp. 33–37. Discussion of techniques and apparatus used for accurate earth satellite tracking.

The New Exploration. T. R. F. Nonweiler. *Aeronautics*, Oct., 1958, pp. 34–37. Discussion of the satellite observations contributing toward the ultimate aim of space flight.

Satellite Survey—Analysis of Their Orbits and Guidance. Murray Stateman. *ARMA Eng.*, Oct.-Nov., 1958, pp. 28–31. Description of five satellite orbits and of their propulsion and guidance requirements based on the fundamental laws of celestial mechanics. Quantitative analyses of the satellites first placed into orbit are presented.

The Earth Satellite Orbit. B. B. Small. *Astronautics*, Jan., 1959, pp. 40, 41, 46, 48. Evaluation of the six orbital elements describing the orbit and the motion of an earth satellite.

Sputnik III. Maurice Allward. *Spaceflight*, Oct., 1958, pp. 303–307, 327. Description of the Soviet satellite and discussion of its significance in the development of astronautics.

Launching the Explorer Satellites. J. L. Stamy. *Space J.*, Summer, 1958, pp. 8–14. Description of Explorer I and III satellites, including details of propulsion systems, instrumentation, and performance.

Spatial Orientation of the Explorer Satellites. Charles Lundquist. *Space J.*, Summer, 1958, pp. 15–20. Discussion of the external forces acting on the Explorer satellites and evaluation of their effect on satellite stability.

Visibility of Orbital Points. W. J. Berger and J. R. Ricupito. *Jet Propulsion*, Dec., 1958, pp. 825–827. Development of equations for computing the values of time at which a vehicle, moving in a known ballistic orbit, appears visible to line-of-sight instrumentation at any specified geodetic station.

Soviets Use Electronic Network to Track Sputnik III. *Av. Week*, Dec. 15, 1958, pp. 48, 49–57 (ff.). Description of scientific findings made with Sputnik III. Magnetometer orientation, magnetic anomaly, and radiation data are discussed.

Use of Satellites for Navigation. A. B. Moody. (*Inst. Navigation 14th Annual Meeting, Santa Barbara, June 19–21, 1958.*) *Navigation*, Summer, 1958, pp. 95–101.

Design of Automatic Flight Control Systems for Manned Space Vehicles. A. J. Kelly. *IAS 27th Annual Meeting, New York, Jan. 26–29, 1959, Rep. 59-32.* 11 pp. 10 refs. Members, $0.50; nonmembers, $1.00. Study showing the effects of human acceleration tolerances on automatic flight control system design. From these tolerances boundary conditions for flight control dynamic performance can be obtained in terms of system parameters. Applications of this technique are shown for two different flight control systems.

An Approach to Equipment Cooling Problems in an Orbital Space Vehicle. J. S. Tupper. *SAE Natl. Aero. Meeting, Los Angeles, Sept. 29-Oct. 4, 1958, Preprint 87B.* 18 pp. Discussion emphasizing reliability in the design of cooling equipment for a short-duration orbital vehicle.

Weather Reconnaissance by Satellites. S. M. Greenfield and W. W. Kellogg. *Astronautics*, Jan., 1959, pp. 32, 33, 77, 78.

Satellite Re-Entry and Recovery. H. L. Gephart. *Holloman Mo. News Bull.*, Sept., 1958, pp. 6, 7. Discussion of the use of retro-firing rockets to force a satellite out of orbit into the atmosphere at a very small angle toward the horizon. Conventional parachutes are used for parachute recovery within the troposphere.

Structures

Some Remarks on the Fundamentals of Structural Safety. Appendix I—The Factor of Safety Required for Scatter of Strength. Appendix II—The f_Z vs. x Curve in the Range of Exceptionally Large Loads. A. Van Der Neut. (*NATO AGARD 6th Structures & Materials Panel, Paris, Nov. 4–8, 1957.*) *NATO AGARD Rep. 155*, Nov., 1957. 23 pp. Study made in order to bring the concept of factor of safety into better harmony with the concept of tolerable probability of failure. A proposal is made for determining ultimate loads with the main characteristic that the emphasis placed so far on the limit load is shifted to a higher load level of much smaller probability of occurrence.

Matrix Methods for Framework Analysis. Appendix I—Determination of the Unit Loading Matrices H and K. Appendix II—The Matrix Programme. Appendix III—Programming for the Framework Using a Pegasus Computer. H. Watson. *Aircraft Eng.*, Dec., 1958, pp. 362–366. Presentation of a strain energy method for the analysis of pin-jointed redundant frameworks, expressed in matrix form suitable for solution on electronic computers.

The Impact of Space Technology on Research and Development—Structures and Materials. R. V. Rhode and J. C. Houbolt. (*NATO AGARD General Assembly, Copenhagen, Oct. 20-29, 1958.*) *U.S., NASA Paper*, 1958. 32 pp. Discussion of the structures and materials problems involved in the design of space-flight vehicles. The nature of the space-flight environment and the general trends in construction are described. Specific examples are given illustrating the severity of the problems considered.

Charts for Beam Design. J. E. Ruzicka. *Mach. Des.*, Dec. 11, 1958, pp. 147–151. Presentation of stiffness coefficients for beams based on a reference stiffness and the position along the beam at which the stiffness is desired.

Bars & Rods

Mestnye Napriazheniia pri Izgibe Kruglogo Prizmaticheskogo Brusa s Ellipticheskim Nesoosnym Otverstviem. Iu. A. Amenzade. *AN SSSR Dokl.*, Sept. 21, 1958, pp. 356–359. In Russian. Study of the problem of local stresses due to bending in the case of round prismatic rods with elliptic noncoaxial holes.

Buckling of Struts of Variable Bending Rigidity. M. M. Abbassi. (*ASME Annual Meeting, New York, Nov. 30-Dec. 5, 1958, Paper 58-A-39.*) *J. Appl. Mech.*, Dec., 1958, pp. 537–540. Solution of a differential equation for struts of variable cross section and for uniform struts under the action of varying axial forces.

Beams & Columns

K Zadache Uprugo-Plasticheskogo Izgiba Balok. S. A. Ambartsumian and M. A. Zadoian. *AN SSSR Otd. Tekh. Nauk Izv.*, Oct., 1958, pp. 130–132. In Russian. Study of the effect of tangential stresses on the elasto-plastic bending of beams.

Web Buckling and the Design of Webplates. K. C. Rockey. (*Struc. Engr.*, Feb.; Sept., 1958.) *ADA Res. Rep. 36*, 1958. 18 pp.; Discussion, 10 pp. 41 refs. Reprint.

Cylinders & Shells

A Fresh Test of the Epstein Equations for Cylinders. E. H. Kennard. (*ASME Annual Meeting, New York, Nov. 30-Dec. 5, 1958, Paper 58-A-18.*) *J. Appl. Mech.*, Dec., 1958, pp. 553–555. Study of Epstein's equations offering direct proof that the equations must hold and giving further reasons for believing that they can be used in practice.

O Kruchenii Kruglogo Tsilindricheskogo Vala s Konicheskoi Chast'iu. B. L. Abramian. *Prikl. Mat. i Mekh.*, Sept.-Oct., 1958, pp. 679–683. In Russian. Study of the torsion of a circular cylinder with a conical end.

Pogreshnost' Priamykh Metodov v Nelineinoi Teorii Obolochek. I. I. Vorovich. *AN SSSR Dokl.*, Sept. 11, 1958, pp. 196–199. In Russian. Evaluation of direct methods in the nonlinear shell theory.

The Flexure of a Uniformly Pressurized, Circular, Cylindrical Shell. J. D. Wood. (*ASME West Coast Conf., Los Angeles, Sept. 8, 9, 1958, Paper 58-APM-13.*) *J. Appl. Mech.*, Dec., 1958, pp. 453–458. Presentation of the moment-curvature relationship and the components of displacement in the cross section of a uniformly pressurized, long, cylindrical shell.

On Thermoelastic Stress-Strain Relations for Thin Isotropic Shells. P. M. Naghdi. *J. Aero/Space Sci.*, Feb., 1959, p. 125. Extension of previous results and modification of the derived stress-strain relations so as to include the thermal effects.

Elasticity & Plasticity

On Finite Deformations of an Elastic Isotropic Material. Fritz John. *NYU Inst. Math. Sci. Rep. IMM 250* (*AFOSR TN 58-955*) [*AD 205-*

348], Oct., 1958. 68 pp. Presentation of results on finite deformations, including geometric analysis for the case of small strain, equations of motion and equilibrium in Lagrange coordinates, invariants of the strain energy function, uniqueness at equilibrium for prescribed boundary displacements, as well as two-dimensional bending and buckling of a thin plate.

Plastic Yielding of Single Notched Bars Due to Bending. G. Lianis and H. Ford. *J. Mech. & Phys. Solids*, Nov., 1958, pp. 1–21. Development of a general method to evaluate the constraint factors of notched bars. Upper and lower bounds for the yield moment are obtained.

On the Problem of the Theory of Elasticity for a Region Containing More Than Two Spherical Cavities. Hiroshi Miyamoto. *JSME Bul.*, No. 2, 1958, pp. 103–108. Solution using the Boussinesq stress-function approach. A series solution is obtained for the problem of elasticity for a region containing more than two spherical cavities whose centers lie on a straight line.

Comment on the Slip Theory of Batdorf and Budiansky. Yoshimaru Yoshimura. *JSME Bul.*, No. 2, 1958, pp. 109–113. Calculation of the characteristic shear function introduced by the two authors for the cases of tension and torsion in circular tubes.

Nekotorye Chastnye Resheniia Uravnenii Osesimmetrichnoi Zadachi Teorii Ideal'noi Plastichnosti i Obobshchenie Resheniia. D. D. Ivlev. *Prikl. Mat. i Mekh.*, Sept.-Oct., 1958, pp. 673–678. In Russian. Derivation of partial solutions for the equations of the axisymmetric problem in the theory of ideal plasticity and generalization of the Prandtl solution for the compression of a plastic layer between two rough surfaces.

Non-Homogeneous Elasticity. M. A. Sadowsky. *Rensselaer Polytech. Inst. Res. Div. Dept. Mech. Rep.* (*AFOSR TR 58-156*) [*AD 162280*], Nov., 1958. 100 pp. Development of the theoretical foundations of nonhomogeneous elasticity. Examples are presented demonstrating the practical value and the applicability of the theory. The torsion of nonhomogeneous materials and the generalization of Boussinesq potentials are also considered.

Citeva Probleme de Elasticitate Plană. N. Preda, Victor Bausic, Th. Havirneanu, D. Horbaniuc, and M. Diaconu. *Iaşi Politeh. Inst. Bul.*, Fasc. 3/4, 1957, pp. 251–270. 12 refs. In Rumanian, with summaries in Russian and French. Derivation of solutions for several problems of plane elasticity.

Simplificarea Ecuaţiilor Metodei Deformaţiilor şi a Calculului Iterativ la Cadre Oarecare. Anton Şesan and N. Orlovschi. *Iaşi Politeh. Inst. Bul.*, Fasc. 3/4, 1957, pp. 245–250. In Rumanian, with summaries in Russian and French. Simplification of equations used in the calculation of deformations.

Plastic Disturbances Whose Speed of Propagation is Less Than the Velocity of a Shear Wave. T. Y. Thomas. *J. Math. & Mech.*, Nov., 1958, pp. 893–900. ONR-supported derivation of the speed of propagation for disturbances or wave surfaces whose speed of propagation is different from zero and numerically less than the velocity of an equivoluminal or shear wave.

Stresses Produced in a Half Plane by Moving Loads. J. Cole and J. Huth. (*ASME West Coast Conf., Los Angeles, Sept. 8, 9, 1958, Paper 58–APM-8.*) *J. Appl. Mech.*, Dec., 1958, pp. 433–436. Study of stresses and displacements induced in an elastic half plane (plane strain) by a concentrated line load moving at a constant speed along its surface.

The Wedge Under a Concentrated Couple: A Paradox in the Two-Dimensional Theory of Elasticity. Eli Sternberg and W. T. Koiter. (*ASME Annual Meeting, New York, Nov. 30-Dec. 5, 1958, Paper 58–A-15.*) *J. Appl. Mech.*, Dec., 1958, pp. 575–581. 21 refs.

Fatigue

Thin Doublers for Fatigue-Resistant Aluminum-Alloy Structures. C. R. Smith. (*IAS 27th Annual Meeting, New York, Jan. 26–29, 1959.*) *Aero/Space Engrg.*, Feb., 1959, pp. 40–42, 49. Description of a method for reducing high bending stresses by use of thin doublers of titanium or stainless steel engaging an extra row of rivets outside the main splice. While this introduces a problem in bimetallic corrosion, the gains in fatigue life and fail-safe features more than offset the extra work required for corrosion prevention.

Plates

A Refined Theory of Elastic, Orthotropic Plates. S. J. Medwadowski. (*ASME West Coast Conf., Los Angeles, Sept. 8, 9, 1958, Paper 58–APM-16.*) *J. Appl. Mech.*, Dec., 1958, pp. 437–443. 19 refs. Presentation of a theory which includes the effect of transverse shear deformation and normal stress, and may be considered a generalization of the classical theory of von Kármán modified by the refinements of the Levy-Reissner-Mindlin theories.

Large Symmetric Deflections of Annular Plates. G. A. Wempner and R. Schmidt. (*ASME West Coast Conf., Los Angeles, Sept. 8, 9, 1958, Paper 58–APM-12.*) *J. Appl. Mech.*, Dec., 1958, pp. 449–452. Presentation of a series solution of the von Kármán equations for axially symmetric deflections of annular plates. A numerical procedure is described for evaluating the coefficients in the series.

Rectangular Orthotropic Thin Plates with Arbitrary Boundary Conditions. Zbigniew Kączkowski. *Arch. Mech. Stosowanej*, No. 4, 1958, pp. 525–549. Extension of a previously developed method to two problems: (a) displacement of the edge $y = 0$ in the case of static load and (b) fundamental frequency of free vibration of the plate.

On the Stiffening of the Edge of the Hole in Orthogonally Aeolotropic Plate with a Circular Hole (Stiffened with the Coaming Plate). Yasuo Nomura. *JSME Bul.*, Aug., 1958, pp. 199–204.

Kriticheskie Davleniia na Krugluiu Plastinku. L. A. Tolokonnikov. *AN SSSR Otd. Tekh. Nauk Izv.*, Oct., 1958, pp. 77–86. In Russian. Study of the axisymmetric equilibrium state of a circular disc of radius a and thickness h, subjected to pressure of intensity q, uniformly distributed over the cylindrical surface.

Ob Izgibe Krugloi Plastinki i Beskonechnoi Polosy, Lezhashchikh na Uprugom Poluprostanstve. A. G. Ishkova. *AN SSSR Otd. Tekh. Nauk Izv.*, Oct., 1958, pp. 87–91. In Russian. Study covering the bending of circular plates and infinite strips supported by elastic semispaces.

The Stresses Produced in a Thin Elastic Plate by a Transverse Impulsive Force. C. J. Maiden. *Philos. Mag., 8th Ser.*, Dec., 1958, pp. 1,413–1,423. Description of tests in which a $^1/_2$ or $^3/_8$ in. diam. weighbar, seated vertically on a thin steel plate, was impacted by a finite mass. The forces applied to the plate and the principal stresses produced at the bottom of the plate are derived. Theoretical and experimental results are compared, and the radial propagation of the disturbance is determined.

Plates, Stiffened

Large Deflection of Stiffened Plates. Appendix I—Computation of Coefficients in Series for Deflection. Appendix II—Method for Determining Elastic Constant α. W. G. Soper. (*ASME West Coast Conf., Los Angeles, Sept. 8, 9, 1958, Paper 58–APM-18.*) *J. Appl. Mech.*,

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Dec., 1958, pp. 444–448. 10 refs. Analysis of nonlinear deflection in orthogonally stiffened plates subjected to static lateral load, treated by using the concept of equivalent orthotropic plates.

Sandwich Construction

Practical Design Suggestions for Users of Brazed Honeycomb Sandwich. F. F. Rechlin. *SAE Natl. Aero. Meeting, Los Angeles, Sept. 29-Oct. 4, 1958, Preprint 82C.* 16 pp. Discussion of conditions in which the brazing may dictate or influence the designer's choice of configuration or material. Methods for taking design advantage of inherent characteristics of the process are also covered.

Testing Methods

Developments in the Application of the Grid Method to Dynamic Problems. A. J. Durelli, J. W. Dally, and W. F. Riley. *Ill. Inst. Tech. ARF (AFOSR TN 58-893)* [*AD 204136*], Dec., 1958. 26 pp. Application of a rubber-thread grid network in a low modulus model material, used in conjunction with a microflash light source to record grid distortions and photoelastic fringe patterns in a model subjected to dynamic loading conditions.

Stress Concentration Factors Under Dynamic Loading Conditions. A. J. Durelli, J. W. Dally, and W. F. Riley. *Ill. Inst. Tech. ARF (AFOSR TN 58-892)* [*AD 204137*], Dec., 1958. 23 pp. Study of stress concentrations resulting from geometric discontinuities in rectangular bars subjected to an axial impact, using dynamic photoelastic methods with a low modulus urethane rubber as the model material.

A Photoelastic Approach to Transient Stress Problems Employing Low Modulus Materials. J. W. Dally, W. F. Riley, and A. J. Durelli. *Ill. Inst. Tech. ARF Rep. (AFOSR TN 58-891)* [*AD 204138*], Dec., 1958. 32 pp. 16 refs. Development of a method for studying dynamic stress distributions. Experimental observations of photoelastic fringe patterns in a rectangular strut subjected to axial impact were made for illustration purposes.

Photoelastic Study of Stress Wave Propagation in Large Plates. J. W. Dally, A. J. Durelli, and W. F. Riley. *Ill. Inst. Tech. ARF (AFOSR TN 58-748)* [*AD 162271*], Nov., 1958. 28 pp. Application of dynamic photoelastic methods, using a low modulus urethane rubber compound as the model material, to study wave propagation in large plates.

Effect of the Weight of Beam on the Measurement of Young's Modulus by Lateral Vibration of Cantilevers. Kiichi Satō. *JSME Bul.*, Aug., 1958, pp. 205–209.

Registriermöglichkeiten für statistisch wechselnde Betriebsbeanspruchungen von Flugzeugteilen. Walter Schuh. *ZFW*, Nov., 1958, pp. 314–319. 33 refs. In German. Discussion of methods for recording and verifying strength measurements in order to determine the fatigue life of aircraft structural components.

Thermal Stress

Transient and Residual Stresses in Heat-Treated Plates. H. G. Landau and J. H. Weiner. (*ASME West Coast Conf., Los Angeles, Sept. 8, 9, 1958, Paper 58—APM-14.*) *J. Appl. Mech.*, Dec., 1958, pp. 459–465. Derivation of equations applied to the determination of stresses during cooling of a uniformly heated plate. The stress distribution sequence and residual stresses are calculated for several values of cooling rate and yield stress.

On Transient Thermal Stresses in a Thin Circular Plate. Włodzimierz Derski. *Arch. Mech. Stosowanej*, No. 4, 1958, pp. 551–558. Determination of the state of stress in a plate due to an axially symmetric nonsteady temperature field.

A Variational Theorem for Creep with Applications to Plates and Columns. J. L. Sanders, Jr., H. G. McComb, Jr., and F. R. Schlechte. *U.S., NACA Rep. 1342*, 1958. 7 pp. 12 refs. Supt. of Doc., Wash., $0.20.

A Theory of Elastic, Plastic, and Creep Deformations of an Initially Isotropic Material Showing Anisotropic Strain-Hardening, Creep Recovery, and Secondary Creep. J. F. Besseling. (*ASME West Coast Conf., Los Angeles, Sept. 8, 9, 1958, Paper 58-APM-17.*) *J. Appl. Mech.*, Dec., 1958, pp. 529–536. 10 refs. AFOSR-supported analysis.

On "A Critical Strain Approach to Creep Buckling of Plates and Shells." N. J. Hoff. *J. Aero/Space Sci.*, Feb., 1959, pp. 117, 118. Critical analysis indicating various shortcomings of previous creep studies.

Thermodynamic Theory of Relaxation Processes. T. D. Shermergor. *Sov. Phys.-Tech. Phys.*, Mar., 1958, pp. 606–613. Translation. Calculation of stress and strain tensors for an inhomogeneous, isotropic solid using the method of the thermodynamics of nonequilibrium conditions. The results are compared with Boltzmann's superposition principle for creep and relaxation.

XUM

Dislocation Model of Low-Temperature Creep. J. Weertman. *J. Appl. Phys.*, Dec., 1958, pp. 1,685–1,689. 19 refs. Presentation of a low-temperature dislocation creep model of the exhaustion type to account for the temperature independent activation energies which were found in recent experiments.

Thermodynamics

Combustion

On the Classification of the Chemistry in Combustion Experiments. Gerald Rosen. *Jet Propulsion*, Dec., 1958, pp. 839–841.

O Termodinamicheskom Ravnovesii Poverkhnostei Sil'nogo Razryva. V. I. Skobelkin. *AN SSSR Dokl.*, Sept. 21, 1958, pp. 431–433. 12 refs. In Russian. Study of the thermodynamic equilibrium in combustion processes in the case of a strong shock front.

Ignition by Flow Over Hot Surfaces. W. G. Courtney. *Jet Propulsion*, Dec., 1958, pp. 836, 837. Investigation indicating that small-scale turbulence at the hot surface may be difficult to avoid in ignition during flow over hot surfaces.

Ignition and Flame Propagation in Dust Clouds. L. E. Line, Jr. *Experiment Inc. FTR TP-131 (AFOSR TR 58-94)* [*AD 162144*], Jan. 31, 1958. 36 pp. 11 refs. Study of the ignition of lycopodium, magnesium, carbon, and boron dust clouds, and of the growth of the combustion zone into quiescent dust clouds suspended in oxygen-nitrogen mixtures. Preliminary results obtained with lycopodium and magnesium are discussed.

Influence of Approach Boundary Layer Thickness on Premixed Propane-Air Flames Stabilized in a Sudden Expansion. W. T. Snyder. *Jet Propulsion*, Dec., 1958, pp. 822–825.

Spectroscopic Studies on Temperature Gradients in Flames. R. H. Tourin. *Comb. & Flame*, Dec., 1958, pp. 353–364. 13 refs. Detailed analysis of self-absorption in a flame in terms of the distribution of the radiating molecular population among the vibrational and rotational energy states. The calculated spectral contours are compared with measured spectra obtained with a special burner in which known temperature gradients could be set up at will.

Heat Transfer

Determine the Static and Total Temperatures of a High Temperature, High Velocity Gas Stream. K. W. Woodfield and Rodger Bloomfield. *GM Eng. J.*, July-Sept., 1958, pp. 53, 54.

An Empirical Method for Calculating Heat Transfer Rates in Resonating Gaseous Pipe Flow. Gerald Morrell. *Jet Propulsion*, Dec., 1958, pp. 829–831.

Effects of Ultrasonics on Heat Transfer by Convection. G. C. Robinson, C. M. McClure, III, and Rudolph Hendricks, Jr. *Am. Ceram. Soc. Bul.*, Sept., 1958, pp. 399–404. 10 refs. Investigation of the effect of 400 kc. sound waves on the temperature drop between heated air and a solid, and between heated oil and a solid.

Low Prandtl-Number Free Convection. J. L. Gregg and E. M. Sparrow. *ZAMP*, Nov. 25, 1958, pp. 383–387. Investigation of the free convection of an isothermal vertical plate for Prandtl Numbers between 0.003 and 0.03. Includes survey of numerical solutions extending over the entire liquid metal range.

Issledovanie Dvizheniia Viazkoi Zhidkosti v Usloviiakh Teploobmena v Oblasti Bol'shikh Chisel Prandtlia. S. I. Kosterin and A. D. Magomedov. *AN SSSR Otd. Tekh. Nauk Izv.*, Oct., 1958, pp. 155–157. In Russian. Results of experiments on the heat transfer and motion of viscous liquids in the region of high Prandtl Numbers.

The Flow of Heat in a Parallel-Faced Infinite Solid. T. P. Newcomb. *Brit. J. Appl. Phys.*, Sept., 1958, pp. 370–372. Presentation of a solution for heat conduction in an infinite slab in which one face is subjected to a linearly decreasing thermal flux, there being no flow of heat at the parallel boundary.

Comparison Between the Linear and Nonlinear Steady-State Behavior of a Heated Tube. B. L. McFarland. *J. Appl. Phys.*, Dec., 1958, pp. 1,682–1,684.

Heat Transfer by Laminar Free Convection About a Vertical Flat Plate with Large Temperature Difference. Tomoshige Hara. *JSME Bul.*, Aug., 1958, pp. 251–254.

Heat-Transfer and Friction Measurements with Variable Properties for Airflow Normal to Finned and Unfinned Tube Banks. R. G. Ragsdale. *U.S., NASA Memo. 10-9-58E*, Dec., 1958. 33 pp. Presentation of a single-line correlation of both heat-transfer and pressure-drop data for electrically heated unfinned tubes by evaluating the density in the Reynolds Number, specific heat, thermal conductivity, and viscosity at the film temperature, and the density in the friction coefficient at the bulk temperature.

VTOL & STOL

Some Thoughts on VTOL. J. H. Stevens. *Aircraft* (Canada), Dec., 1958, pp. 10–14, 18, 85. Discussion of the design principles and operational characteristics of various VTOL configurations; other determinant factors are also discussed.

VTOL Aircraft—The International Field. *The Aeroplane*, Dec. 12, 1958, pp. 857–867. Survey of 48 helicopter and 11 VTOL aircraft types, including design and performance specifications.

Britain's VTOL Industry. *The Aeroplane*, Dec. 12, 1958, pp. 851–854. Survey of 11 VTOL types, including design and performance specifications.

The S.C. 1 from the Pilot's Viewpoint. Tom Brooke-Smith. *The Aeroplane*, Dec. 12, 1958, pp. 855, 856.

The X-14 VTOL Airplane—A Design Tool. J. A. O'Malley, Jr., and L. C. Landphair. *SAE Natl. Aero. Meeting, Los Angeles, Sept. 29-Oct. 4, 1958, Preprint 95B.* 18 pp. 14 refs. Description of the design and VTOL and STOL performance characteristics of the X-14 research airplane. Stability, control, and design potential are discussed.

Hiller X-18 Research VTOL Aircraft. P. R. Dowden. *AHS Newsletter*, Dec., 1958, pp. 2–11. Analysis of the design, system, and performance characteristics of a VTOL aircraft, and discussion of scheduled flight-testing programs.

Flight Testing Experiments with the Tilt-Wing Aircraft. W. Z. Stepniewski and P. J. Dancik. (*IAS 27th Annual Meeting, New York, Jan. 26–29, 1959*). *Aero/Space Engrg.*, Feb., 1959, pp. 43–49. Description of the aircraft and the test program, including information obtained on its usefulness as a research tool, as well as data on stability, control, and maintenance.

Jet Engine Control and Attitude Control in Vertical Attitude VTOL Aircraft. J. W. Baxter and R. C. Finvold. *SAE Natl. Aero. Meeting, Los Angeles, Sept. 29-Oct. 4, 1958, Preprint 95A.* 13 pp. Discussion of engine thrust control characteristics for the nonafterburning Ryan X-13. Aircraft control problems which are unique to vertical attitude aircraft are also discussed. The design concept is explained, and the auxiliary engine controls required for stabilization of the attitude control as well as the attitude stabilization system are described.

Some Thoughts on Optimum Combinations of Wings and Vertical Thrust Generators in VTOL Aircraft. W. Z. Stepniewski. *SAE Natl. Aero. Meeting, Los Angeles, Sept. 29-Oct. 4, 1958, Preprint 95C.* 19 pp. 13 refs. Review of some VTOL problems in order to indicate probable ways toward an optimization of the wing-power plant combination of jet and airscrew type configurations. VTOL aircraft from low subsonic to Mach 2+ are considered.

Vehicles for Research on Hovering and Low Speed Flight. A. D. Wood. *Canada, NAE Quart. Bul.*, July 1–Sept. 30, 1958, pp. 1–17. Description of propulsion and control test vehicles, and discussion on further development of experimental techniques.

Piloting Procedures and Some Human Factors Aspects of the VTOL—Transition Cycle of the X-13 Aircraft. P. F. Girard. *IAS 27th Annual Meeting, New York, Jan. 26–29, 1959, Rep. 59-7.* 14 pp. Members, $0.50; nonmembers, $1.00. Detailed description of a typical VTOL and transition mission flight. Piloting procedures and techniques are discussed and unique human factors presented.

The First Vertical Take-Off Airliner; Flight Development of the Rotodyne. *Fairey Rev.*, Sept., 1958, pp. 2–7. Brief description of the aircraft and of the developmental testing programs covering structures, stability and control, ground resonance, tip jet system, rotor rig, swash plate mechanism, and fatigue tests.

VTOL Transport Configuration Studies. F. C. Phillips and K. Irbitis. (*CAI Annual Gen. Meeting, Toronto, May 27, 1958.*) *Can. Aero. J.*, Nov., 1958, pp. 305–315. Summarized description of a study on the preliminary design and analysis of VTOL aircraft, with particular emphasis on the drawbacks and problems inherent in such aircraft. Five fixed wing configurations are considered.

Flight Development of the Fairey Rotodyne. G. F. Champlin. *Am. Helicopter*, June, 1958, pp. 6–8, 12, 13.

Jet Deflection Flight Tests. P. F. Ashwood and D. Lean. (*RAeS J.*, Aug., 1958, pp. 539–561.) *Shell Av. News*, Sept., 1958, pp. 14–18.

Water-Based Aircraft

Tank Tests on a Model of the Piaggio P155 Flying-Boat. W. A. Crago. *Saro Prog.*, No. 2, 1958, pp. 12–14.

IAS PUBLICATIONS AVAILABLE

No. FF-20 ***Supersonic Transports Proceedings.*** Papers and Discussions presented at the IAS 27th Annual Meeting Session.
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No. FF-16 ***Inertial Guidance*** by W. Wrigley, R. B. Woodbury, and J. Hovorka (This is a revised version of IAS Preprint No. 698, presented at the IAS 25th Annual Meeting, now out of print.)
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Inc., and Assistant General Manager of the Metal Products Division. He continues as Manager of the division's Production Department.

• **Lear, Inc.** . . . Lear Astronics Division has named Leonard R. Ambrosini to head the newly formed Analytical Engineering Department. Also, Dunstan Graham has been made head of the new Systems Management Office.

• **Lockheed Aircraft Corp.** . . . Georgia Division has announced the creation of a "Conception-to-Retirement" quality follow-up plan on its aircraft and allied products. Permanent monitoring is being done by a new Reliability Branch, which has been organized from a nucleus of three line departments—Quality Control, Flight Operations, and Field Service. Gordon Thorn, formerly Assistant Chief Engineer, has been appointed Head. William Rieke has been named JetStar Project Manager.

• **Marquardt Aircraft Co.** has named Don L. Walter to the newly created position of Vice-President of the Power Systems Group.

• **Northrop Aircraft, Inc.,** has changed its name to Northrop Corporation. Northrop Division at Hawthorne, Calif., has taken the new name of Norair.

• **Radio Corp. of America,** Defense Electronic Products, has elected Walter G. Bain as Vice-President, Washington office. Mr. Bain will be responsible for maintaining relations with United States defense agencies, assisting in major defense contract negotiations and directing the activities of the Washington office.

• **Republic Aviation Corp.** has renamed its Guided Missiles Division the Missiles Systems Division.

• **Ryan Aeronautical Co.** has announced establishment of a military relations office at Huntsville, Ala. The office will be in Room 302, Huntsville Electric Service Center Building, 112 Gallating St., S.W.

Goodyear Aircraft Corp. has built the world's largest fiberglass radome, 68 ft. in diameter and more than 7 stories high, for the Missile Detection Systems Section of General Electric Co.'s Heavy Military Electronics Department. The radome is air-transportable and can be erected by a 6-man crew in approximately 80 hours.

• **Space Technology Laboratories, Inc.,** has appointed Dr. Robert R. Bennett Program Director for the Minuteman ICBM system.

• **Thompson Ramo Wooldridge Inc.** . . . Thompson - Ramo - Wooldridge Products Co. has announced the following additions to their technical staff: Stuart T. Schy, Keith E. Curtice, Charles A. Pfretzschner, and Dr. R. Curtis Johnson, computer specialist.

• **Vitro Corp. of America** has elected Frank B. Jewett, Jr., to the post of Executive Vice-President and Harper Woodward to the Board of Directors.

• **Westinghouse Electric Corp.** . . . Air Arm Division has appointed Dr. Patrick Conley as Manager.

IAS News — IAS Sections

Antelope Valley Section

Jet Transports

S. A. Butchart and **J. Fischel,** of the NASA High Speed Flight Station, spoke at the December meeting on **"Flight Studies Pertinent to the Operation of Jet Transports."**

Mr. Butchart is an aeronautical research pilot for NASA and was the High Speed Flight Station test pilot on the KC-135 program investigating the operations of jet transports. Mr. Fischel is the assistant head of the Stability and Control Branch of the Flight Station and was the flight-test engineer in charge of the KC-135 test program.

HAROLD E. ROYSTON
Publicity Chairman

Baltimore Section

ASW Problem in Free World Defense

An insight into the enormous difficulties inherent in detecting enemy submarines was presented in a discussion of the ASW problem by **Rear Adm. John S. Thach,** Commander Hunter-Killer Force, U.S Atlantic Fleet, at a classified dinner meeting in December. At the meeting, held at The Martin Co. plant in Middle River, Md., guests and members were welcomed by Bill Bergen, Executive Vice-President.

Admiral Thach augmented his talk with slides, and the discussion period following provided an opportunity to ask questions and receive answers within the bounds of security regulations.

LEONARD ATRAN, *Secretary*

Boston Section

Prof. Trilling Speaks on Soviet Education

Leon Trilling, recently returned from a trip to the Soviet Union where he was an official guest of the Soviet Government under the U.S. Government-sponsored Exchange-Professor Program, was guest speaker at the December meeting. Professor Trilling spoke on Soviet engineering and engineering education and commented that any discussion must take into account the fact that the standards and values of Soviet society are quite different from ours and from those of other Western nations. He pointed to three circumstances which strongly influence education in the Soviet Union: the planned society, the rapid rate of technical and economic development, and the intensity of pressure toward gaining higher education.

Professor Trilling said that the purpose of higher education in the U.S.S.R. is the production of technical and scientific personnel for the service of the state. The needs of the state are, therefore, embodied in all educational planning; there exists in each education specialty but a single curriculum, managed and controlled by the Ministry of Higher Education, which is responsible for the planning of curricula and enrollments throughout the U.S.S.R. The only exceptions to the single-curricular rule are the courses at a few of the better institutions located mainly in Moscow and Leningrad.

A Soviet candidate for a degree in engineering matriculates for $5^1/_2$ years. The first 2 years of his training are similar to the first 2 years in a Western university; the last $3^1/_2$ years are, however, quite different. The lecture method of instruction is retained, but written examinations and homework are not. Written examinations are replaced by oral examinations in which the student may be challenged re-

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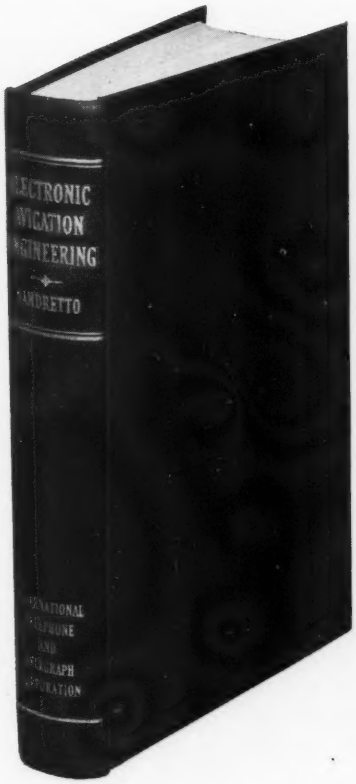

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garding any aspect of his work to date. Homework is replaced by a project type of work, of which Professor Trilling gives the following example:

A candidate for a degree in aeronautical design has chosen as his project the design of an airplane wing. He devotes 1 year to the theoretical aerodynamic design of the airfoil and another year to structural analysis of the span. He spends the third year on those phases of production which reflect the design of the wing—i.e., tooling, manufacturing processes and techniques, and the economics of aircraft production.

There are 2 million students enrolled in the day, evening, and correspondence schools of the Soviet higher educational system at the present time. Of the 1.3 million who are day students, 600,000 are in the fields of engineering and natural science. It is expected that 80,000 students per year will graduate as engineers, trained in 169 engineering specialties, to meet the predetermined requirements of the Soviet educational and industrial communities. The United States output of graduate engineers is 30,000 per year.

Professor Trilling explained that in the planned society of the U.S.S.R. engineers are produced and placed in accordance with the needs of the state. An elaborate screening process in the secondary schools singles out those students who will be given the benefit of further education. As a result of this process, the mortality rate of candidates for entrance to the institutions of higher learning is approximately 75 per cent. The placement of graduates in jobs after they receive their degrees is based on, *first*, the needs of the state; *second*, the marital status and family responsibilities of the student; and *last*, the wishes of the student.

Professor Trilling observed that Soviet higher education is devoted mainly to the sciences, with some attention given to the "humanities," which generally take the form of dialectical materialism, the history of the Communist Party, and a foreign language—usually English or German. He drew no conclusions in his lecture, but he asked the audience to ponder the question, "Why does the Soviet plan call for 80,000 engineers per year?"

J. J. KIRBY, *Secretary*

Dayton-Cincinnati Section

The North American T-39 Trainer

David Hoffman, Manager of Plans and Programs, Los Angeles Division, North American Aviation, Inc., presented the story of the North American T-39 or UTX Trainer at the December dinner meeting.

Mr. Hoffman reviewed the background of the development of the T-39 Trainer, pointing out that work on the aircraft was initiated in the fall of 1956 when North American received a letter from the USAF indicating interest in potential "off-the-shelf" procurement of the utility-type aircraft. He pointed out that the T-39 or UTX was first flown in May, 1958, has completed Phase I evaluation successfully, and is now completing Phase II flight evaluation at Edwards AFB.

The T-39 aircraft is capable of carrying a crew of two, plus four passengers, with a normal gross weight of approximately 16,000 lbs. It has provisions for handling cargo in addition to serving as a trainer and personnel carrier. Mr. Hoffman reviewed the performance, mechanical design, operating characteristics, and maintainability of the T-39, pointing out the economic advantages of the T-39 utility aircraft as contrasted to operation of larger aircraft. Color movies of the first flight of the T-39 were shown and a question-and-answer period followed Mr. Hoffman's talk.

D. F. JAMISON, *Secretary*

Detroit Section

Thompson Heard on VTOL Aircraft

Members and guests heard **Donald M. Thompson,** Technical Director, Aviation, Transportation Corps, Department of the Army, discuss **"U.S. Army Aviation Research and Development and VTOL Aircraft"** at a December meeting.

Mr. Thompson outlined the reasons for Army interest in VTOL configurations, briefly charting the manner and mechanisms by which R&D is accomplished. He described the present state of prototype development, effectively utilizing 16-mm. color films of presently operating models and full-scale vehicles. His discussion included unloaded rotor, retractable rotor, and tilting rotor convertiplanes; deflected slipstream (highly flapped wing-multiple propeller) aircraft; rotable wingtip ducted fan configurations; and tilt wing test vehicles. A description and films of the Aerial Jeep program now being conducted by Chrysler, Piasecki, and Aerophysics concluded the meeting.

Dr. Philip W. Lett, Jr., Chief Engineer, Defense Engineering, Defense Operations Division, Chrysler Corp., organized the program. Copies of the paper are available on request as long as the limited supply lasts.

WILLIAM M. SPREITZER
Secretary

✦ ✦ ✦

Hagerstown Section

NASA and Space Exploration

The major reasons for probing the unknown were discussed at the December meeting by **Edgar M. Cortright,** Chief of Programs—Advanced Technology, NASA. He gave as the chief reasons the following: scientific exploration, the exploitation of space, and the search for technological advances. Some of the means of exploring space are by vertical probe, lunar probe, satellites, and Mars and Venus probes. He said that in the current satellite program taken over by the NASA four Vanguards are yet to be launched.

Mr. Cortright also discussed some history of engine and fuel development and the necessary future development to obtain sufficient power for manned space flight. Also, some of the problems of manned space flight were mentioned, particularly those dealing with the long-duration Mars and Venus probes. An important outgrowth of space exploration will be its aid in the field of meteorology as related to the earth and its atmosphere, he said.

E. L. HARKLEROAD
Secretary

Indianapolis Section

Dr. Bennett Speaks on Electronics' Role in Space Exploration

Dr. Robert R. Bennett, Associate Director of the Electronic Laboratory, Space Technology Laboratories, spoke on **"Space Exploration and the Role of Electronics."** Dr. Bennett's remarks concerned the electronic elements of missiles, satellites, space travel, and the Pioneer moon rocket. He discussed two types of space travel: (1) satellites around the earth for weather reconnaissance and communications and (2) point-to-point space flight.

Dr. Bennett said that efficiently packaged electronic equipment has recently been made available for missile systems. He described the purpose of the space mission as threefold: (1) instrumentation for space research, (2) communication, and (3) manned travel and logistic support.

WILLIAM R. HANEY, JR.
Secretary

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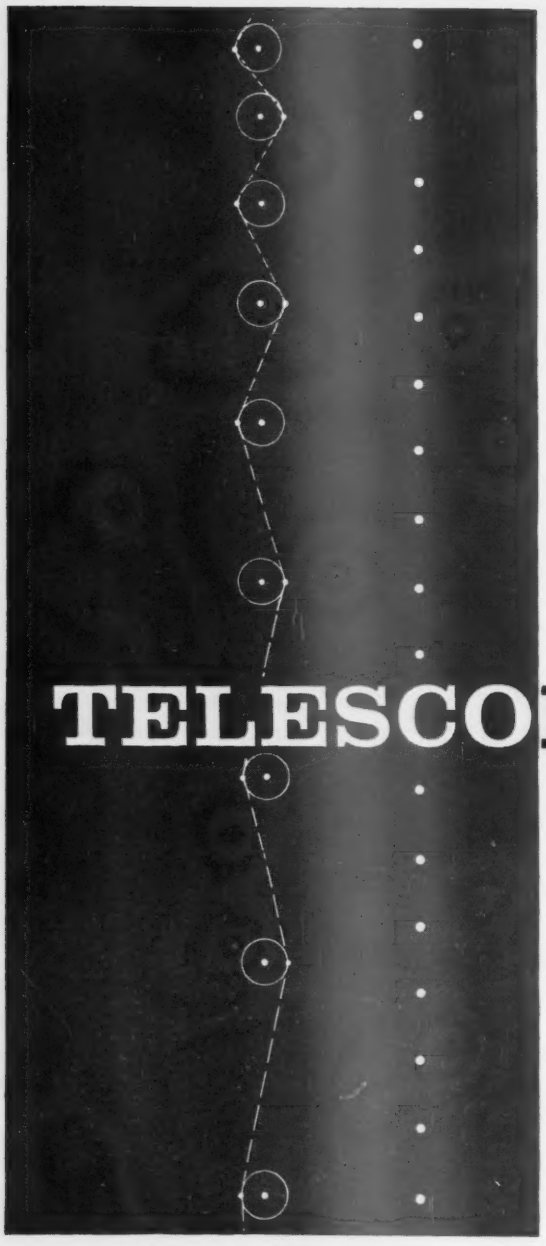

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ACOUSTICS, SOUND, NOISE

Comparison of the Take-Off Noise Characteristics of the Comet Jet Airliner and of Conventional Propeller-Driven Airliners. Laymon N. Miller, Leo L. Beranek, and Robert M. Hoover. Prepared for The Port of New York Authority. Cambridge, Mass., Bolt Beranek and Newman, Inc., March, 1958. 34 pp., illus, diagrs., tables.

AERONAUTICS, GENERAL

NASA Conference on Some Problems Related to Aircraft Operation; A Compilation of the Papers Presented at Langley Research Center, Langley Field, Va., Nov. 5–6, 1958. 332 pp. illus., diagrs., tables.

The original presentation and this record are considered supplementary to, rather than substitutes for, the Administration's system of complete and formal reports. A list of the conferees, who are members of the aircraft industry and the military services, is included.

Contents: Take-Off, Approach, and Landing Characteristics: (1) Factors Which Influence Landing Approach Speeds, F. J. Drinkwater III, M. D. White, and G. E. Cooper. (2) Flight Investigation of an Automatic Throttle Control in Landing Approaches, L. J. Lina, R. A. Champine, and G. J. Morris. (3) Controllable Thrust Reverser for Flight and Landing, S. B. Anderson and G. E. Cooper. (4) A Review of Statistics of Airplane Landing Contact Conditions, N. S. Silsby. (5) Tire-to-Surface Friction Especially Under Wet Conditions, R. H. Sawyer, S. A. Batterson, and E. N. Harrin. (6) Study of Taxiing Problems Associated With Runway Roughness, B. Milwitzky. (7) Flight Studies of Problems Pertinent to Low-Speed Operation of Jet Transports, J. Fischel, S. P. Butchart, G. H. Robinson, and R. A. Tremant. Flying and Handling Qualities: (8) Some Possible Developments in VTOL Transport Aircraft, M. O. McKinney, Jr. (9) Use of Flight Simulators for Pilot-Control Problems, G. A. Rathert, Jr., B. Y. Creer, and J. G. Douvillier, Jr. (10) Flying Qualities Associated With Electronic Flight Control Systems, S. A. Sjoberg. (11) A Review of Atmospheric Turbulence and Its Significance to Jet Transport Operations, R. Steiner and M. R. Copp. (12) Pitch-Up Problem—A Criterion and Method of Evaluation, M. Sadoff. (13) Some Effects of Yaw Damping on Airplane Motions and Vertical-Tail Loads in Turbulent Air, J. Funk and T. V. Cooney. (14) Flight Studies of Problems Pertinent to High-Speed Operations of Jet Transports, S. P. Butchart, J. Fischel, R. A. Tremant, and G. H. Robinson. Flight Safety: (15) A Compensated Static-Pressure Tube for Fuselage-Nose Installations, W. Gracey and V. S. Ritchie. (16) Electrostatic Hazards During High-Speed Fueling, I. I. Pinkel. (17) Jet-Fuel Jettisoning, H. H. Lowell. (18) Crash-Fire-Prevention System for the T-56 Turbopropeller Engine, A. M. Busch. (19) Jet-Transport Ditching Characteristics, L. J. Fisher and W. C. Thompson. (20) Aircraft Maintenance as a Possible Factor in Some Types of Flutter, D. J. Martin. (21) Some Aspects of Compressor and Turbine Blading Reliability, R. H. Kemp and J. W. Weeton. Aircraft Noise: (22) Boundary-Layer Noise at Subsonic and Supersonic Speeds, G. H. Jordan and N. J. McLeod. (23) Jet-Engine-Noise Reduction, W. J. North. (24) Noise Problems Associated With Ground Operations of Jet Aircraft, H. H. Hubbard. (25) The Shock-Wave Noise Problem of Supersonic Aircraft in Steady Flight, D. J. Maglieri and H. W. Carlson. Characteristics of Future Type Transport Aircraft: (26) Several Methods for Reducing the Drag of Transport Configurations at High Subsonic Speeds, R. T. Whitcomb and A. R. Heath, Jr. (27) Powerplants for Supersonic Transport Airplanes, A. V. Zimmerman. (28) Some Considerations of Supersonic and Hypersonic Airplanes as Commercial Transports, J. L. Jones and D. H. Dennis.

AVIATION MEDICINE

Aviation Medicine, An Annotated Bibliography, Vol. 2, 1953 Literature. A. J. Jacobius, M. J. Wilkins, L. Kassianoff, R. B. Slie, and S. L. Whitehead. St. Paul, Minn., Aero Medical Assn., 1959. 354 pp. $5.00.

This second volume of the *Aviation Medicine Bibliography* has been prepared by the Bibliography Section of the Science and Technology Division in the Library of Congress under Government Order NAonr-31-58. The first volume, published in 1956, was annotated in the May, 1957, issue of the AERONAUTICAL ENGINEERING REVIEW, vol. 16, No. 5, p. 217. Subject coverage of the material extends over the following broad areas in aviation: history, physiology, pathology and pharmacology, psychology, preventive medicine and sanitation, special problems in high-altitude and space flight, and miscellaneous problems. Among the 1,400 annotated entries are included a number of Russian and other Slavic-language items. As in the preceding volume, availability of materials is indicated by a symbol for the library which possesses the item, followed by a control number to be used in requesting the material. Where the primary source of an article was not available, this information is denoted by the use of an asterisk next to the abstract. In style, arrangement, type, and form, the abstracts follow closely those of the first volume.

In the second volume, all entries are identified by item numbers and are listed under these numbers in the indexes. Cumulated corporate-author and subject indexes, combining the entries of Volumes I and II, are included, and to enable the reader to trace references in Volume I, a key has been supplied which refers from the old (author-year) to the new (numerical) item designation.

DOCUMENTATION

Tools for Machine Literature Searching; Semantic Code Dictionary, Equipment, Procedures. J. W. Perry and Allen Kent. (*Library Science and Documentation, Vol. 1*; Jesse H. Shera, General Editor.) New York, Interscience Publishers, Inc., 1958. 972 pp., diagrs., tables. $27.50.

Contents, Part One: Introduction to Machine Literature Searching: (1) Introduction, J. W. Perry and A. Kent. (2) Logical Principles of Information Retrieval, J. W. Perry and A. Kent. *Part Two*: Engineering of Machine Literature Searching Systems: (3) Introduction to Engineering of Searching Systems, J. W. Perry and A. Kent. (4) Costs for Machine Literature Searching, A. Kent and J. W. Perry. *Part Three*: Procedures for Analyzing, Encoding and Searching of Recorded Information; (5) Procedures for Preparation of Abstracts for Encoding, J. Melton. (6) Telegraphic Abstracts in the Field of Ordnance A. Kent and J. W. Perry. (7) Standardized Abstracts from Articles in *New York Times*, T. H. Rees, Jr. (8) Telegraphic Abstracts—Coordination with Other Information Processing, A. Rees, A. Kent, and J. W. Perry. (9) The Semantic Code, J. L. Melton. (10) Special Codes, T. H. Rees, Jr., and J. W. Perry. (11) Automatic Encoding for Machine Searching, J. S. Melton, J. F. Rees, and D. E. Cort. (12) A Method for Automatic Encoding for Languages Other Than English, J. L. Melton and J. S. Melton. (13) Encoding of Information Previously Indexed, A. Kent and J. W. Perry. (14) Encoding of Information Previously Classified, J. Melton. (15) Introduction to Analysis of Questions, J. Melton and J. W. Perry. (16) Automatic Correlation of Information for Purposes of Commercial Intelligence, T. H. Rees, Jr., A. Kent, and J. W. Perry. (17) Operational Division of Files, A. Kent and J. W. Perry. (18) The Western Reserve University Searching Selector, J. W. Perry. (19) The Use of Electronic Computing Machines for Literature Searching, S. F. Dennis. *Part Four*: A Thesaurus of Scientific and Technical Terms: The Semantic Code Dictionary.

EQUIPMENT

Aircraft Communications Systems. J. H. H. Grover. 127 pp., illus., diagrs., tables. $6.00.

This companion volume to the author's *Radio Aids to Air Navigation* contains details of some modern British airborne radio communications equipment and will be useful both as a reference guide for the experienced flight radio operator and as an aid for students working toward their license. The material is divided into three separate sections: *Part 1* contains theoretical circuit descriptions of contemporary equipment, *Part 2* contains actual setting-up and practical operating instructions for the items described, and *Part 3* deals with other equipment and ancillaries.

Contents: (1) Introduction and Basic Systems. (2) The Marconi AD87 Transmitter and AD8882 Receiver. (3) The Marconi Aircraft Transmitter Type AD97. (4) The Marconi Aircraft Transmitter Type AD107A. (5) The Marconi Aircraft Transmitter Type AD107B. (6) The Standard STR18B/2 Transmitter. (7) The Standard STR18C Communications Installation. (8) Aircraft Receivers. The Marconi Types AD108 and AD114. The Standard SR18B/2. (9) The Main Communications Receiver. Marconi Type AD94. (10) The AD97/AD108 Installation. (11) The AD107/AD114 Installation. (12) The STR18B/2 Installation. (13) The STR18C Installation. (14) VHF Transmitter/-Receivers. (15) Contemporary American Equipment. (16) Ancillaries. Index.

Fundamentals of Transistors. Leonard M. Krugman. 2nd Rev. Ed. New York, John F. Rider Publisher, Inc., 1958. 168 pp., diagrs. $3.50

The previous edition of this title appeared in 1954. In bringing the volume up to date, the following revisions and additions were made:

(1) The theory, construction, and operation of modern and most significant semiconductor devices have been included—i.e., the surface barrier, intrinsic, drift, avalanche, and spacistor types.

(2) Illustrative circuits and design principles covered in the amplifier, oscillator, and high-frequency application sections have been modified to reflect current conditions.

(3) Review questions have been added at the end of each chapter to emphasize major topics.

(4) Each chapter also includes a bibliography referring to more advanced treatment of specific derivations, concepts, circuit applications, and design techniques.

HEAT TRANSFER

Principles of Heat Transfer. Frank Kreith. Scranton, Pa., International Textbook Co., 1958. 553 pp., illus., diagrs., tables. $11.

A basic introduction to the field of engineering heat transfer, this book has been organized as a text, but it can also serve as a reference for practicing engineers interested in fundamental techniques of analyzing heat-transfer problems. It is assumed that the reader has an elementary knowledge of thermodynamics, fluid dynamics, d.c. circuit theory, calculus, and differential equations, although a certain amount of review of these topics has been included. The presentation endeavors to convey to the reader a physical understanding of the processes by which heat is transferred and to provide him with the tools necessary to obtain quantitative solutions to engineering problems involving one or more of the basic modes of heat flow.

The author is Associate Professor of Mechanical Engineering, Lehigh University.

Compact Heat Exchangers; a Summary of Basic Heat Transfer and Flow Friction Design Data. W. M. Kays and A. L. London. (Technical Report No. 23, Nov. 15, 1954, Contract N6ONR-251 TO 6, Project NR 065-104.) New York, McGraw-Hill Book Co., Inc., 1958. 156 pp., diagrs., tables. $6.00.

MATHEMATICS

Seminars on Analytic Functions, Vols. 1 and 2. Institute for Advanced Study, Princeton, N.J. (*US AFOSR TN 58-750.*) Princeton, N.J., 1958. *Vol. 1*, 346 pp.; *Vol. 2*, 320 pp.

These two volumes contain the half-hour addresses delivered in the five seminars at the Conference on Analytic Functions held September 2–14, 1957, at the Institute for Advanced Study, Princeton, N.J. The principal addresses have been published as a book under the title *Analytic Functions* by the Princeton University Press.

Contents, Vol. 1: On Properties of Domain Functionals, S. Bergman. On a Generalized Dirichlet Problem for Plurisubharmonic Functions and Pseudo-Convex Domains. Characterization of Silov Boundaries, H. J. Bremermann. On Oka's Theorem for Stein Manifolds, H. J. Bremermann. Functional Equations and Dirichlet Series, K. Chandrasekharan. On Currents in an Analytic Complex Manifold, G. de Rham. Some Applications of the Theory of Distributions of Several Complex Variables, L. Ehrenpreis. Analytic Fibre Bundles over Holomorphically Complete Spaces, H. Grauert. Multipliers on Complex Homogeneous Spaces, R. C. Gunning. An Elementary Method for the Local Study of an Analytic Set, M. Hervé. Ideals of Meromorphic

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Vol. 2: Abel's Theorem for Open Riemann Surfaces, L. V. Ahlfors. Determination of an Automorphic Function for a Given Analytic Equivalence Relation, L. Fourès. A Theorem Concerning the Existence of Deformable Conformal Maps, M. Heins. A Direct Construction of Abelian Differentials on Riemann Surfaces, A. Pfluger. The First Variations of the Douglas Functional and the Periods of the Abelain Integrals of the First Kind, H. E. Rauch. Stability Problems on Boundary Components, L. Sario. Approximation by Bounded Analytic Functions, J. L. Walsh. Induced Representations, R. Bott. Characteristic Numbers of Homogeneous Domains, F. Hirzebruch. Automorphic Forms in Half-Spaces, M. Koecher. The Fourier Coefficients of Automorphic Forms Belonging to a Class of Real Zonal Horocyclic Groups, J. Lehner. Asymptotic Formulae for the Fourier Coefficients of Multiplicative Automorphic Functions, H. Peterson. Automorphic Functions and Integral Operators, A. Selberg. Joint Spectra in Topological Algebras, R. Arens. Algebraic Properties of Classes of Analytic Functions, R. C. Buck. Multiplicative Functionals on Banach Algebras, L. Carleson, Linear Inequalities and Closure Properties in Normed Linear Spaces, K. Fan. Function Algebras, A. M. Gleason. Fatou's Theorem for Generalized Analytic Functions, K. Hoffman. On Rings of Bounded Analytic Functions, S. Kakutani. Derivations of Banach Algebras, I. Kaplansky. The Laplace Transform on Groups and Generalized Analytic Functions, G. W. Mackey. Rings of Meromorphic Functions, H. Royden. Analytic Functions on Locally Convex Algebras, L. A. Waelbroeck. Rings of Analytic Functions, J. Spectral Decomposition of Operators in a Banach Space and the Analytic Character of their Resolvent, F. Wolf.

Elementary Matrix Algebra. Franz E. Hohn. New York, The Macmillan Co., 1958. 305 pp., tables. $10.

Of potential use to engineers in every field, as well as to physical, biological, and social scientists, this text has been developed over a period of years for a course in Linear Transformations and Matrices given at the University of Illinois. The essential material of the subject is presented at the junior-senior level and developed with the objective of preparing the reader to study the applications of matrices in his special field.

Contents: (1) Introduction to Matrix Algebra. (2) Determinants. (3) The Inverse of a Matrix. (4) Rank and Equivalence. (5) Linear Equations and Linear Dependence. (6) Vector Spaces and Linear Transformations. (7) Unitary and Orthogonal Transformations. (8) The Characteristic Equation of a Matrix. (9) Bilinear, Quadratic, and Hermitian Forms. *Appendix I:* The Notations Σ and Π. *Appendix II:* The Algebra of Complex Numbers. *Appendix III:* The General Concept of Isomorphism. Bibliography. Index.

NAVIGATION

Electronic Avigation Engineering. Peter C. Sandretto. New York, International Telephone and Telegraph Corp., 1958. 772 pp., illus., diagrs. $9.50.

Electronic Avigation Engineering deals with electronic devices applied to transport aviation, with the emphasis placed on the engineering principles of the systems described. The various systems are grouped in four classes based on the operational problems of aircraft in (1) flight toward a destination airport, (2) flight near that airport, (3) approach and landing, and (4) movement on the airport surface. Descriptions are given of direction finders; four-course, TL, and omnidirectional ranges; Consol, Post Office position indicator, Navaglobe, Navarho, Decca, Delrac, Dectra, Radux, loran, radar, radio high-altitude and landing altimeters, Doppler drift, inertial systems, distance measurement, Gee, Tacan, surveillance radar, fixed-beam and radar low-approach systems; and to define the position of aircraft on the airport surface: traffic pads, ground magnetic loops, and surface radar.

The author is Vice-President and Technical Director of ITT Laboratories.

POWER PLANTS

Gas Turbine Power. George M. Dusinberre and John C. Lester. 2nd Ed. Scranton, Pa., International Textbook Co., 1958. 334 pp., illus., diagrs., tables. $8.00.

This elementary textbook on gas turbines stresses the mechanical engineering aspects of the subject and has been extensively revised since it last appeared in 1952. The emphasis on the thermodynamic and heat balance aspects of the gas turbine featured in the previous edition has been retained, but the scope of the book has been broadened to include material on free-piston gas turbines, gas-turbine automobiles, closed-cycle gas-turbine nuclear power reactors, and turbojet, turboprop, and ram-jet engines.

RESEARCH

Federal Funds for Science. VII. The Federal Research and Development Budget, Fiscal Years 1957, 1958, and 1959. National Science Foundation. Washington, Superintendent of Documents, 1958. 78 pp. $0.45.

Contents: (1) The Current R&D Budget, Fiscal Years 1957, 1958, and 1959. (2) Administering Agencies. (3) Funds for Conduct of Research and Development. (4) Performance Components. (5) Character of Work. (6) Scientific Fields. (7) Funds for Increase of R&D Plant. (8) Federal Research and Development Trends. *Appendix A:* Technical Notes. *Appendix B:* List of Research Centers. *Appendix C:* Statistical Tables.

SAFETY

Aircraft Maintenance Error Study; Covering 12 Months Period, Norfolk, Va., U.S. Naval Aviation Safety Center, 1958. 40 pp., illus., diagrs.

The period covered by this report is calendar year 1957 and includes all major and minor accidents in which the primary or secondary cause was maintenance, service, or supervisory error. The breakdown of accidents by aircraft systems involved focuses attention on frequently repeated errors and reveals areas where errors are most numerous.

SPACE TRAVEL

Proceedings of Lunar and Planetary Exploration Colloquium, Held July 15, 1958, at the Rand Corporation, Santa Monica, Calif. (*Vol. I, No. 2.*) Downey, Calif., Missile Division, North American Aviation, Inc., 1958. 23 pp., illus., diagrs.

Contents: A Look at the Future Space Effort, B. B. Chew. Guidance and Control of Space Exploration Vehicles, Dr. A. R. Maxwell Noton. Lunar Vehicles, G. A. Olson. Panel Discussion, Moderated by Dr. A. R. Hibbs. Syntax of Space Exploration, Dr. A. G. Wilson. Making Measurements by Hard-Landing Vehicles, Dr. Lee Stephenson. Discussion of Lunar Measurement Program, Moderated by S. M. Greenfield. Colloquium Members.

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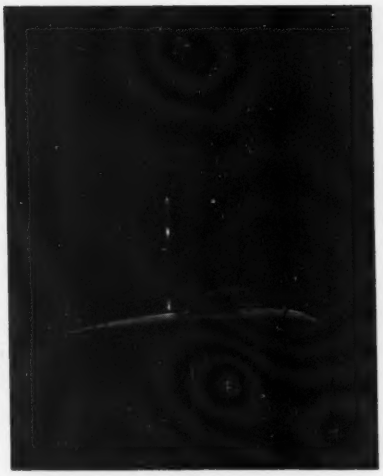

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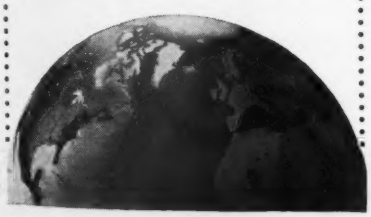

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